IMPLICATIONS OF DIDACTIC PHENOMENOLOGY AND PROGRESSIVE MATHEMATICIAN IN MATHEMATICS LEARNING

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Abstract
RME is based on the view that mathematics is a human activity. This view implies that mathematics should be close to the daily lives of students and provide ample opportunity for students to construct their own knowledge. Thus the presentation of mathematics is properly oriented to student characteristics, in other words, is predicted to be understood and dominated by students. Based on this, the study of the development of heuristic design RME as didactical phenomenology and progressive mathematician becomes very important to do. In this case, the didactical phenomenology and progressive mathematician analysis are used as the basis for building hypothetical learning trajectory that is part of the validation of achieving learning trajectory in RME.
Keywords: Didactical Phenomenology, Progressive Mathematician, RME

INTRODUCTION

In some mathematics education research, it is often found that mathematics is one of the difficult subjects mastered by students. Mathematics is described as a subject that is not liked by the students; causing students' learning outcomes in these subjects tend to be low. These researchers often offer a variety of alternative learning approach that supports the improvement of students' mathematical ability, among others, through realistic mathematics education.

Realistic Mathematic Education (RME) is one of the approaches that emphasizes mathematics learning as a human activity and is sourced from everyday activities. These daily activities are activities that are real and close to the students. Gravemeijer (1994) asserts that the daily activity is an essential part of learning mathematics, where students are expected to find back (reinventions) mathematical concepts through the teachers' guidance.

Although the idea of RME first appeared in the Netherlands, but the concept of realistic mathematics education has penetrated into various parts of the world, including Indonesia. On its development, the researchers in the country try to adopt the principles and characteristics of RME through the local instructional theory. The interesting point from the local instructional theory is not only the development of learning which refers to the RME theory, but how to apply the principles of RME optimally. In this regard, several studies in the Netherlands have proposed various prototypes that refers to the content validity of RME through conjectured learning trajectory (Gravemeijer, 1994) which then encourages the study design through hypothetical learning trajectory (HLT) (Bakker, 2004).

On some searches on HLT research, researchers have discovered various prototypes that support the optimization of the principle of RME. In Bakker's (Bakker & Gravemeijer, 2006) study for example, it is disclosed how students find the concept of average by investigating a picture of a herd of elephants. Students are required to determine how much elephants are in the picture using their own strategies. There are various strategies done by the students such as counting the number of elephants in each row, determining the number of elephants at the end of the line, and also classifying the elephants into certain groups. Bakker discovered what he called "average box" that emerged from the largest estimate from a herd of elephants in the picture as a hypothesis.

Furthermore, the students' ability in estimating the number of elephants in a picture emerged due to the phenomenon that is organized into a problem situation that requires students to estimate the mathematical concepts. It is a heuristic which arose from a phenomenon that according to Freudenthal (1983) is called as a didactic phenomenology. Didactic phenomenology is a heuristic design that is characterized by the identification of learning activities that support individual activities and overall class discussion in which students engage in progressive mathematician (Gravemeijer, 1994). It should be noted that progressive mathematician would not exist if the didactic phenomenology do not. As confirmed by Gravemeijer, Cobb, Bowers & Whitenack (2000), the implications of didactic phenomenology is to create a learning setting in which students can collectively negotiate sophisticated solutions to real problems based on the experience of the individual activities and class discussions.

Another example is the research conducted by Bintoro & Zuliana (2013) which examines the efforts of students to determine the trapezoidal area formula using the phenomenon of Kudus' traditional house. Both researchers found that the mathematics achievement increased in the material of the trapezoid area. Research design approach is used to reveal trajectory learning either at the stage of preparation, design and retrospective analysis. Overall, this study has uncovered the effective application of RME through the designed pedagogical framework, but the optimization principle of RME in the study has not been clearly delineated. Researchers seem to have not revealed how the students respond while learning trajectory was designed and implemented. Although there were review of the preliminary design of models and tools, but based on didactic phenomenology, trials of instructional design is important to do. They will provide a didactic anticipation when this research design is experimented.

By comparing the results of the researches above, it appears that in order to achieve the learning trajectory on an RME design, an in-depth study of the principles of RME is needed. This is considered as fundamental since students' perception of a study is unique. In this case, didactic anticipation on the RME implementation is very important, although it can be performed by the research cycle design. Freudenthal (1983) as the key initiator of RME did not make explicit heuristics on the optimization of RME principles, but RME theories that he proposed such as didactic phenomenology (Freudenthal, 1983) illustrates that there are ideal conditions that must be met in order for the RME principles to be optimally achieved. Some researchers prefer to describe the principles and characteristics of this in a conjectured learning trajectory, but according to the author, there are certain conditions in which unpredictable RME can only be achieved if the characteristics / conditions of RME principles as stated by Freudenthal, can be present or be predicted. For example, a contextual problem or phenomenon based on Feudenthal (1983), is "to be organized", meaning that students can organize problems through the estimated concept. These conditions must be achieved so that students can perform progressive mathematician in order to arrive at the expected formal notation. It is clear that when researchers created a learning trajectory, they should be able to predict that progressive mathematician would have occurred. This is the basic need for in-depth study on the optimization of the RME principles in learning.

LITERATURE REVIEW

Realistic Mathematic Education

The emergence of RME basically could not be separated from the paradigm shift in student-centered learning. RME can be expressed as a humanistic learning in the view that a student could not be regarded as a passive recipient. Students should be given the widest opportunity to rediscover the knowledge of mathematics based on the real world. The real world is a concrete world which is delivered to the students through the application of mathematics (de Lange in Hadi 2010; Sadiq & Mustajab, 2010).

The real world in RME is the starting point of learning. Through this real world, the students' knowledge is built through a continuous transformation process which is shaped and reshaped. In other words, knowledge is not a free entity to be controlled, but the ideas and concepts are constantly updated and refined. The process that is mentioned by de Lange (1987) as a conceptual mathematician is described in a schematic form as below.

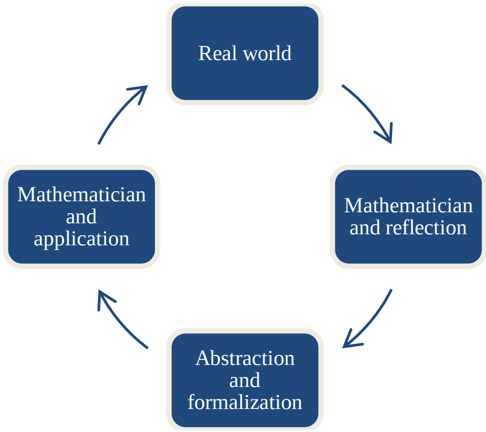

Figure 1. Conceptual Mathematician (de Lange, 1987)

The illustration of concept development process above does not have a final point, which indicates that the process is more important than the end result. The starting point process emphasizes the conception known by the students. This is due to the assumption that every student has the original concept of mathematical ideas.

Related to mathematics, Freudenthal (Fauzan, 2002) stated that it is *an activity of solving problems, of looking for problems, and also an organizing activity of a subject matter. This can be a matter from reality, which has to be organized according to mathematical patterns if they have to be solved. It can also be a mathematical matter, new or old results, of your own or others, which have to be organized according to new ideas, to be better understood, in a broader context, or by an axiomatic approach*.

Freudenthal (Fauzan, 2002) further stated that mathematics is a key process in RME. Therefore, the study of mathematics should be presented in the form of guided reinvention, where the process experienced by the students will be the same as the process in which mathematics was discovered by mathematicians.

Furthermore, there are two terms in mathematician, ie horizontal mathematician and vertical mathematician. Both are described by Treffers (Supinah, 2008) as follows.
Horizontal mathematician
Horizontal mathematician is an activity that changes contextual problems into mathematical problems (Gravemeijer, 1994). At this stage, students conduct informal steps to change the real situation into mathematical symbols, making a model (model of), making schemes, finding relationships, and so forth so that the problem can be solved mathematically.

Vertical mathematician
According to Gravemeijer (1994), vertical mathematician is an activity of formulating problems in a diverse way of solving math using various rules of mathematics in general, for example: finding a short method in the relationship between the concepts and strategies and then implement it, representation of relationships in formulas, repair and adjustment of mathematical models, use of different models, and generalizations. Turmudi (Hamzah, 2004: 30) stated explicitly that the activities included in horizontal mathematician and vertical mathematician are as follows.

Activities in horizontal mathematician include:
1)Identifying mathematical problems in a more general context. 2) Designing mathematical schemes. 3) Formulating and visualizing problems in different ways. 4) Finding relationship (correlation). 5) Finding regularity. 6) Recognizing isomorphic aspects in different issues. 7) Transferring the real-world problems into mathematical problems; and 8) Transferring the real-world problems into appropriate mathematical models.
Activities in vertical mathematician include: 1)Determining a relationship in a formula. 2) Proving regularities. 3) Verifying and adjusting the models. 4) Using different models. 5) Combining and integrating models. 6) Formulating a new math concept; and 7) Generalizing.

Didactic Phenomenology
The term phenomenology can be described as an objective investigation of the logic essence and meaning of an experiment in understanding a topic (Whittles 2007). This term is basically widely used in the fields of philosophy; nevertheless, the approach of phenomenology is also used in many other fields, especially to explore someone's mental characteristics based on experience or imagination.

In the context of education, particularly in RME, the term phenomenology was first disclosed by Freudenthal (1973). Freudenthal (1983) described it as a method of studying the relationship between mathematics, history and education. In this matter, he contrasted the term phenomena and concepts. According to him, phenomenon refers to what we want to understand, create interest in, or structure, while the concept is a thought process that organizes these phenomena. Based on the both description, Freudenthal then defines phenomenology as follows.

> *Phenomenology of a mathematical concept, a mathematical structure, or a mathematical idea means, in my terminology, describing this noumenon in its relation to the phenomena of which it is the means of organizing, indicating which phenomena it is created to organize, and to which it can be extended, how it acts upon these phenomena as a means of organizing, and with what power over these phenomena it endows us. If in this relation of noumenon and phenomenon I stress the didactical element, that is, if I pay attention to how the relation is acquired in a learning-teaching process, I speak of didactical phenomenology of this noumenon. (…) if "is … in a learning and teaching process" is replaced by "was … in history", it is historical phenomenology (Freudenthal, 1983)*

Referring to the definition above, there is association between concepts and phenomena. This association is expressed by Freudenthal (1973) as didactic phenomenology. So, didactic phenomenology can be seen as the study of relationships between mathematical concepts and phenomena that arise in connection with the process of learning the concepts and applications (Bakker in Kizito, 2013).

Regarding to the implications of didactic phenomenology, Gravemeijer (Bakker, 2004) stated that didactic phenomenology is an analysis and an instructional design basis on how the term is studied and thought out. Gravemeijer (1994) added that the purpose of the investigation done by the phenomenologist is to find a problem situation based on a certain situation that can be generalized, and to find a situation that can evoke the paradigmatic solution procedure and can be taken as a basis for vertical mathematician. In the same context, Drijvers (2002) stated that didactic phenomenology can be served as investigation (heuristics) in designing activities that encourage students to develop their strategy. Based on that definition, the didactic phenomenology can be seen as a study or investigation of RME pedagogical framework that encourages learners to be engaged in progressive mathematician.

As the main initiator of RME, Freudenthal (1983) explicitly stated that the core of didactic phenomenology is a phenomenon that needs to be organized with the concept of thought (Freudenthal, 1983). Its essence is translating the phenomenon into a problem situation that is meaningful for students and creating a need for the organization with a particular concept (Bakker, 2004). This suggests that the phenomenon presented should be eligible to be transformed into a situation problem which will then be organized. Conceptually, it is described as follows.

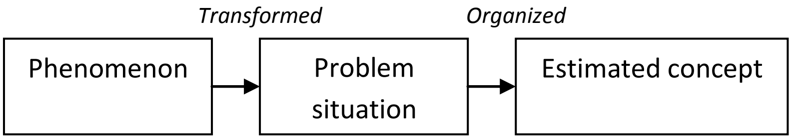

Figure 2. Early Process of Didactic Phenomenology

Based on the opinion above, it is clear that the principle of didactic phenomenology can be run optimally if the built didactic design meets the expected criteria of didactic phenomenology. Treffers & Goffree (1985), explicitly provides four criteria that must be fulfilled in a didactic phenomenology, namely: (1) concept formation: enables students to be natural and motivated in accessing math; (2) model formation: provides a solid foundation for students to learn the operation, procedure, notation, and formal rules in relation to other models as a support for thinking; (3) applicability: utilizing reality as the source and domain to be applied, (4) practice: specialized skills training for students in the applied situation.

Progressive Mathematician

To build or construct a mathematical concept, a mathematical process which consists of horizontal mathematician and vertical mathematician is required. According to the language, the word 'mathematician' has the same meaning as mathematic which is described as the modeling of a phenomenon in the sense of looking for relevant mathematics towards a phenomenon or constructing a mathematical concept based on a phenomenon (Wijaya, 2012).

Some experts' opinion on mathematician such as; according to Freudenthal (in Gravemeijer, 1994), mathematician in the study of mathematics is a process of improving and developing mathematical ideas gradually. It is in accordance with the opinion of De lange (Wijaya, 2012) which defines mathematician as organizing events in finding regularities, relations and mathematical structures using the knowledge and early skills that have been built.

Mathematician process is recognized in the RME principle in building models and mathematical concepts. According to De Lange (Hadi, 2005), the mathematician process in RME involves two main processes which are horizontal mathematician and vertical mathematician. On the other hand, Traffers (Gravemeijer, 1994) described the mathematical process of horizontal and vertical mathematician in the learning process as follows.

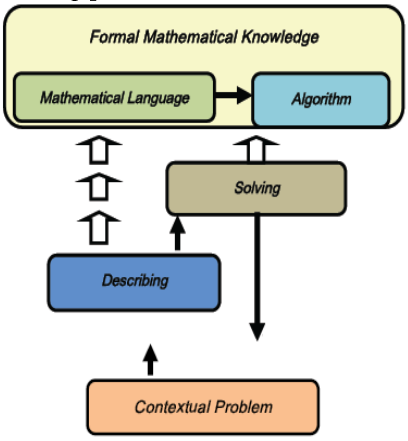

Figure 3. Horizontal and Vertical Mathematician based on Gravemeijer

Gravemeijer (1994) mentioned horizontal mathematician as mathematician in contextual issues, i.e. students starting from contextual questions, trying to analyze using their own language and symbols, then resolving the problem. While vertical mathematician as a mathematical issue starts from contextual issues, but in the long term, students can develop certain procedures that can be used to solve the problems without using contextual help. Horizontal mathematician is described as the students' ability to understand the context of the problem using mathematical language or method. On the other hand, vertical mathematician is illustrated as the transformation or reorganization using a mathematical algorithm.

The importance of mathematician is also utilized by PISA to develop students' mathematical abilities. In the explanation of PISA (2015: 9), it is stated that the mathematical processes is an activity that describe what someone is doing to connect the contextual problems with math, how to solve the problems and the ability that underlies these processes. PISA describes mathematician process cyclically, as shown in the figure below:

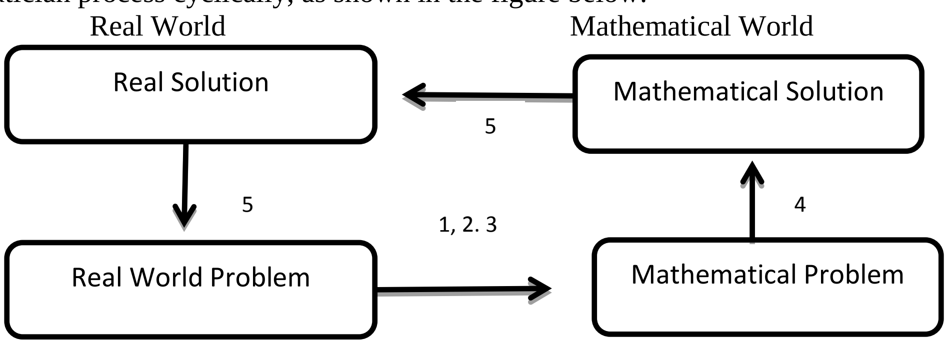

Figure 4. PISA's Mathematician Process (OECD, 2009, in Wijaya, 2012:45)

PISA's version on mathematician in relation to build models and mathematical concepts begins by identifying contextual issues, looking for relationships with symbols, patterns related to problems to form mathematical models or *off model*. The process of contextual issues phase towards math problems is done by the horizontal mathematician process. While the process of finding a solution to a mathematical problem in the form of a mathematical representation, formal mathematics and generalization, uses the vertical mathematician or the *for model* and *formal model*

The process of building or finding mathematical concepts using a mathematical model that has been previously established is a process of progressive mathematician. This is based on Wijaya's statement (2012: 47) that, using models, schemes, diagrams, mathematical symbols for progressive mathematician as an important case in the discovery and development of mathematical concepts by students. Models, in this case, relates to the situation models and mathematical models developed by the students themselves. Gravemeijer (1994: 102), furthermore adds that "in RME, models are placed at in intermediary level between situated and formal knowledge". The use of the model by students themselves acts as a bridge for students from the real situation to the situation of a mathematical abstraction or informal-formal mathematics.

Gravemeijer (1994) mentions four levels or stages in developing mathematical models, among others are: 1) Situational level, which is the most basic level of modeling where knowledge and models are still evolving in the context of a problem situation used. 2) Referential level - At this level, models and strategies that have been developed are not in the situation context but have been referred to the context. At this level students create a model for developing context situation so that the model result in this level is described as the situation model or the *off model*. 3) General level - At this level, models that were developed by students have already led to the search for mathematical solutions. This level is called a model for a solution or the *for model*, and 4) Formal level - At a formal level, students work using symbols and mathematical representation. This level is the stage of formulation and confirmation of the mathematical concepts that were built by the students.

METHOD

The method used in this paper is reviewing literature from various sources, focusing on the implication of didactic phenomenology and progressive mathematician in mathematics learning. Explicitly, this study discusses; (1) the implications of didactic phenomenology in building hipothetical learning trajectory, and (2) progressive mathematician implications in building mathematical modeling.

DISCUSSION

As mentioned previously, the approach on realistic learning principles could theoretically be developed in building an understanding towards a specific mathematical concept. Whittles (2007) for example, used the principle of didactic phenomenology to analyze the topic on cryptology in class 10. In this case, Whittles (2007) used the historical phenomenology as the study or questions about the historical context in which certain mathematical concepts are presented to create interest about why and how they appear in this context. Then the didactic phenomenology is used to study the relationship between mathematical concepts and the phenomena that emerged in connection with the teaching and learning process of the concepts and applications. Whitless (2007) explicitly stated that historical and didactic is a standpoint designed for his study. He called historical phenomenology of cyptology as selected samples which is organized chronologically and followed by didactic phenomenology. Didactic phenomenology will be informed later by field-testing developed materials on cryptology with teachers of school-teaching mathematics, learners of school-going mathematics and second year students in the further and education phase (FET) studying towards a teacher's qualification with mathematics for teaching as one of their main subjects.

In the context of RME, RME principle approach is used to build a learning trajectory. Despite the RME principle approach being more theoretical, the achievement of the learning trajectory will explicitly give a real picture of the successful implementation of RME in learning. This is based on a skeptical idea that students do not necessarily think based on the teacher's interpretation, especially with traditional learning conditions which are inherent and have been long practiced.

The Implications of Didactic Phenomenology Principle

Didactic phenomenology is one of the RME principles which is widely used by researchers as one of the RME heuristic design. Didactic phenomenology is used as an analysis of structural connections between mathematical concepts and phenomena arising from the learning perspective. There are at least two keywords of didactic phenomenology analysis: (1) how to introduce an understanding of the relationship between a certain mathematical concepts based on theoretical RME perspective with the phenomenon that is built, (2) what type of activity should be designed to introduce various types of reasoning needed.

In the context of didactic phenomenology, phenomenon became the main keyword that should be considered. As expressed by Freudenthal (1983) in explaining the main challenge of didactic phenomenology is finding the phenomenon of "beg to be organized". Freudenthal (1983) has provided an overview of this phenomenon, for example: geometry pictures are organized by construction and geometric proof, phenomenon of "numbers" is organized by its understanding of the decimal system, and so on.

Related to the importance of building a phenomenon, Gravemeijer (1994, 1999) explained that the purpose of the phenomenology investigation is to identify the problem situation through situation-specific approach that can be generalized. In this case, the phenomenon is built into a situation that encourages the mathematical problem to be developed vertically. This condition will provide a comprehensive overview of how to build a visible hypothetical learning trajectory especially in choosing the appropriate contextual problems.

Bakker (2004) used didactic phenomenology to build a hypothetical learning trajectory. As a source of didactical phenomenology, he uses the resources of previous studies, historical phenomenology, and interviews. A description of the steps in building HLT is illustrated in the following diagram.

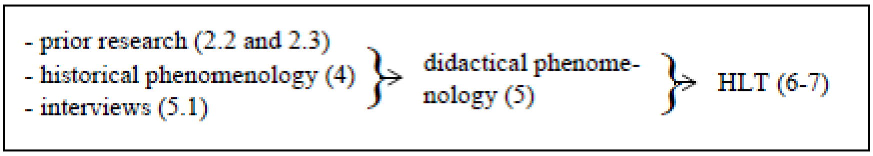

Figure 5. The use of didactic phenomenology in building HLT (Bakker, 2004)

Referring to the diagram above, it is clear that didactic phenomenology learning can be used to predict the learning trajectory. Through historical phenomenology, the linkages between the phenomenons with previous mathematical concepts can be clearly defined, including how the concept was discovered and also how these concepts are used. While the historical phenomenology helps anticipate the process of guided reinvention, the didactic phenomenology helps to translate the phenomenon into a problem situation that is meaningful for students and creates the organization needs through a particular concept. Meanwhile, the interview is used to determine students' initial knowledge in a certain concept that is well thought out.

An example of didactic phenomenology study is described in Bakker (2004), how students organize an image of a herd of elephants into a grid used to estimate the total number of elephants in the image. Bakker described the grid as "average box". In this case, Bakker built the distribution side phenomenon which is organized by estimates. Students are given the strategies shown in the figure below.

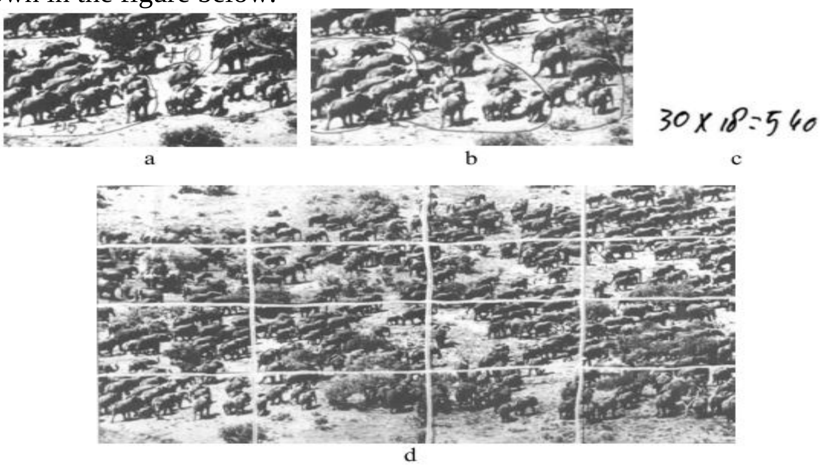

Figure 6. Students' strategy in estimating the number of elephants (Bakker, 2004:112)

There are four strategies used: (1) students create groups, guess the number of elephants in each group, then add the numbers (15 + 10 + ...); (2) the students create a group with a fixed amount and an estimate how much group went into it (each about 10 elephants); (3) calculate the number of elephants based on the number of elephants in the long side of the field and on the wide side of the field, then multiply them; (4) make a grid, then choose an 'average box' which one of them is shown as follows.

24	18	15
19	40	33
29	45	28
36	25	11

Figure 7. Average Box (Bakker, 2004:118)

Based on the average box above, students then do a dividing (moving the excess amount in one box to another so that each box approaches the same number), then multiply by the number of the box in the grid.

The Implications of Progressive Mathematician Principle

Freudenthal (Fauzan, 2002) furthermore stated that the mathematician is a key process in RME. The reasons are, first, mathematician is not just as a main activity in doing mathematics, but it also introduces students to a situation that is close to students' daily life. Second, the final stage of mathematics is formalization through axiomatization. The final stage is not a starting point when thinking of mathematical concepts, as found in traditional mathematics instruction. Therefore, the study of mathematics should be presented in the form of giving students the chance to reinvent the ideas and concepts of mathematics with teachers' guidance through exploration of various contextual issues, which is done by RME learning approach.

Mathematician process is a key process in RME which is not only as a main activity in doing mathematics but also introduce students to situations close to students' daily life in searching mathematical models. This process occurs in horizontal mathematician stage, where students' activities in completing a contextual problem into a mathematical model so that the solutions can be obtained. In addition, the end of the mathematician stage is formalization through mathematical concept of axiomatization performed by vertical mathematician process so the process of students' mathematical abilities improves. The process of forming or developing mathematical concepts which have been previously formed is a facet of progressive mathematician.

The progressive mathematician concept shows that the students' ability in describing or constructing mathematical models to find a solution is a competence that can be done if the learning process gives students the opportunity to find a solution using appropriate stages based on students experience with teachers' guidance.

CONCLUSION

Didactic phenomenology and progressive mathematician are parts of the heuristics RME design that need to be developed in building a learning trajectory. Although both are more theoretical, but in order to achieve optimal implementation of RME, a study of didactic phenomenology and progressive mathematician becomes very important to conduct. Based on this study of the implications of didactic phenomenology and progressive mathematician, the following conclusions present the essence of both designs. 1) Didactic phenomenology is relationship analysis between mathematical concepts and phenomena to build a learning trajectory based on a historical phenomenology analysis and mathematical phenomenology at a certain mathematical concept. Meanwhile, a mathematical phenomenology is an analysis on how mathematical objects which are thought, organizes a mathematical phenomenon, whereas the historical phenomenology is an analysis on how and with what organization of activity, varying concepts, procedures and tools are constituted over time. 2) Mathematician is a key process in RME. The reasons are, first, mathematician is not just as a main mathematical activity but also introduce students to a situation that is close to their daily lives. Second, the final stage of mathematics is formalization through axiomatization. The final stage is not a starting point when thinking of mathematical concepts, as found in traditional mathematics instruction. The process of forming the formal mathematics from first stage to the second is in the form of progressive mathematician. Therefore, the study of mathematics should be presented in the form of giving students the chance to reinvent the ideas and concepts of mathematics with teachers' guidance through exploration of various contextual issues, which is done by RME learning approach.

REFERENCES

Bakker, A. (2004). *Design research in statistics education on symbolizing and computer tools*. (Dissertation Utrecht University). Utrecht University, Netherland.

Bakker, A., & Gravemeijer. (2006). An historical phenomenology of mean and median. *Educational Studies in Mathematics*, 62, hlm. 149–168.

Bintoro, H.S. & Zuliana, E. (2013). Pembelajaran matematika materi luas trapesium dengan pendekatan luas persegi panjang menggunakan model pembelajaran matematika realistik berkonteks rumah adat kudus. *Prosiding Seminar Nasional Matematika dan Pendidikan Matematika* Vol. 1 hlm. 153-165. Surakarta: Universitas Sebelas Maret

de Lange, J. (1987). *Mathematics, insight, and Menaing. Teaching, Learning and Testing od Mathematics for the life and social sciences.* Utrecht: Vakgroep Onderzoek Wiskundeonderwijs en Onderwijs-computercentrum (OW & OC).

Drijvers, P. (2002). Learning mathematics in a computer algebra environment: obstacles are opportunities. *Zentralblatt für Didaktik der Mathematik, 34*, hlm. 221-228

Fauzan. (2002). *ApplyingRealistic Mathematics Education (RME) in teaching geometry in Indonesian primary schools***. (**Thesis University of Twente). University of Twente, Enschede, Netherland.

Freudenthal, H. (1971). Geometry between the devil and the deep sea. *Educational Studies in Mathematics*, 3 (3/4), hlm. 413-435.

Freudenthal, H. (1973). *Mathematics as an educational task*. Dordrecht: Reidel.

________. (1983). *Didactical phenomenology of mathematical structures*. Dordrecht: Reidel.

Gravemeijer, K. (1994). *Developing Realistic Mathematics Education*. Utrecht: Kluwer Academic Publishers.

Gravemeijer, K. (1999). How emergent models may foster the constitution of formal mathematics. *Mathematical Thinking and Learning*. 1 (2), hlm. 155-177.

Gravemeijer, K.., Cobb, P., Bowers, J. S., & Whitenack, J. W. (2000). Symbolizing, modeling and instructional design. In P. Cobb, E. Yackel & K. J. McClain (Eds.), *Symbolizing and communicating in mathematics classrooms: Perspectives on discourse, tools, and instructional design*, hlm. 225-273. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Hadi, S. (2010). *Introduction to Realistic Mathematics Education*. Yogyakarta: P4TK Matematika.

Hadi.(2005). *Pendidikan Matematika Realistik Indonesia dan Implementasinya*. Banjarmasin. Indonesia: Tulip

Hamzah, U. (2004). *Mensinergikkan pembelajaran matematika dengan bidang lain*. Makasar: Pustaka Ramadhan

Kizito, R.N. (2012). *Realistic Mathematics Education (RME) as an instruction design perspective for introducing the relationship between the derivative and integral via distance education*. Dissertation Faculty of Education. University of Stellenbosch

Shadiq, F., & Mustajab, N.A. (2010). *Pembelajaran matematika dengan pendekatan realistik di SMP*. Yogyakarta: P4TK Matematika

Supinah. (2008). *Pembelajaran matematika SD denganpendekatan kontekstual dalammelaksanakan KTSP*. Yogyakarta: P4TK Matematika.

Whittles, K. 2007. *Cryptology: a didactical transposition into a grade 10 school mathematics classroom.* Dissertation Faculty of Education. University of the Western Cape.

Wijaya, A. (2012). *Pendidikan Matematika Realistik*. Yogyakarta: Graha Ilmu.