Effectiveness of Realistic Mathematic Education and Means Ends Analysis towards Students' Mathematics Achievement

Indah Nurmalasari [1],✉

[1] Sekolah Dasar Negeri Pondok Bahar, Kota Tangerang, Indonesia

Abstract

This study aims to determine differences in mathematics achievement between Realistic Mathematic Education (RME) class and Means Ends Analysis (MEA) class. A quasi-experimental method was adopted to obtain the answer to the research question. Sample of the study consisted of 65 fourth-grade students were selected by cluster random sampling from population that is all of students in SDN Kembangan Selatan 01 Pagi. The sample consisted of by two groups, i.e. RME class that involved 32 students and MEA class that involved 33 students. The mathematics achievement data obtained by 6-item written test. Based on t-test analysis can be concluded that there is difference between students' mathematics achievement by using RME and MEA. In this context, the research findings indicate that students' mathematics achievement who received RME better than MEA. One of the factors supporting the finding is that the RME provides more opportunities for students to build meaningful learning through a process of reinventing the mathematical concepts.

Keywords: Realistic Mathematic Education, Means Ends Analysis, Elementary School, Mathematics Learning

Keefektifan Pendidikan Matematika Realistik dan Means Ends Analysis terhadap Hasil Belajar Matematika Siswa

Abstrak

Penelitian ini bertujuan untuk mengetahui perbedaan hasil belajar matematika antara kelompok yang dikenai pembelajaran Realistic Mathematic Education (RME) dan Means Ends Analysis (MEA). Metode eksperimen semu diadopsi untuk memperoleh jawaban dari pertanyaan penelitian. Sampel dalam penelitian ini terdiri dari 65 siswa kelas IV yang diambil secara cluster random sampling dari populasinya yaitu seluruh siswa di SDN Kembangan Selatan 01 Pagi. Sampel tersebut terbagi atas dua kelompok yaitu kelompok yang dikenai RME sebanyak 32 siswa dan kelompok yang dikenai MEA sebanyak 33 siswa. Instrumen hasil belajar matematika siswa menggunakan tes tertulis berbentuk esai sebanyak 6 butir soal. Berdasarkan analisis terhadap uji t dapat disimpulkan bahwa terdapat perbedaan hasil belajar matematika siswa dengan menggunakan RME dan MEA. Dengan kata lain, temuan penelitian ini mengindikasikan bahwa siswa yang dikenai RME lebih baik dibandingkan dengan MEA. Salah satu faktor pendukung temuan tersebut adalah siswa lebih memaknai pembelajaran melalui proses menemukan kembali konsep-konsep matematika.

***Kata kunci**: Realistic Mathematic Education, Means Ends Analysis, Sekolah Dasar, Pembelajaran Matematika*

✉Corresponding Author:

E-mail: indahnurmalasari276@gmail.com

INTRODUCTION

Mathematics is perceived by majority of students as difficult to learn, because they hold beliefs about mathematics is an abstract object and separated from human thought **(Purnomo, Suryadi, & Darwis, 2016)**. Moreover, the learning of mathematics emphasizes students to memorize a wide range of formulas, calculate, do the questions that make students tend to be passive **(Purnomo, Kowiyah, Alyani, & Assiti, 2014)**. Therefore, majority of students dislike mathematics. Addition to the perception of mathematics as a subject, students are often bored in mathematics learning because learning environments that do not support it meaningfully. The learning environments include (1) textbooks which became the only one primary literature for guide the teaching; 2) emphasizing rote-memorization on fixed rules; 3) lack of students' activities and one's direct communication; and 4) involvement of students directly finding his own knowledge through learning.

In line with the above, there are still many students who have difficulty applying mathematics in real life situations. Students are difficult to understand what had been learned and also cannot connect the mathematical contents to the experience they have. Even though the students are expected to be capable to solve problems in life that lived as a form of consequence that they have learned mathematics **(Purwanto, 2010)**. That matter has impacted on the student's mathematics achievement and doesn't match expectations. If this is left unchecked and there is no improvement in the learning process, it will interfere and be a burden to learn advance mathematics. Therefore, to overcome these problems in order to unsustainable there needs to be improvement in the learning process of mathematics that occur during this time. Teachers need to correct learning patterns and seek an innovation in learning activities, namely by linking real-life experiences of students with mathematics learning so that it is easier to understand the material presented. Mathematics learning which involves students not only active, but a shared activity between them, because with activity through the experience of the concepts and ideas will be formed **(Lestari, Prahmana, & Wiyanti, 2016)**. Furthermore, the content standards of Permendiknas No. 22/2006 on the subjects of mathematics states that: "In every occasion, the learning of mathematics should begin with an introduction of the problems which accords to the situation". One of the innovations in the learning of mathematics is connecting mathematics to real-world problems of students, in this case the introduction of the problem which accords to the situation and engage students actively is Realistic Mathematic Education (RME).

RME uses realistic or real-world problems students to explain mathematical concepts. The mathematics concepts will be meaningful for students if the learning process involves realistic problems or implemented in, and with a context **(Wijaya, 2012)**. The mathematical concepts that seem abstract will be made more concrete by using the real world as a bridge or something that could be imagined by the students. Students will seek understanding and knowledge of mathematical concepts through their experience to solve realistic problems given. Hans Freudenthal contend that "Mathematics is an activity and not as a ready-made-system" **(Gravemeijer & Doorman, 1999)**. According to his view of mathematics, it is not a finished product but a form of activity or process. This process is done through horizontal mathematics and vertical mathematics. In horizontal mathematics departs from the real world into the world of abstract/mathematical symbol while the vertical mathematics is the process in the world of abstract/the symbol.

Mathematics learning that uses RME, enable students to become directly involved in understanding the mathematics material presented, so as to improve the ability of students to understand the material. This is because in principle, RME is developed by three principles, namely: (1) the pattern of guided reinvention (rediscovery) in constructing the concept of the rule process of mathematization (progressive mathematics). Students should be given the opportunity to experience the same process as

the mathematical concepts found; (2) didactical phenomenology, the situations given in a mathematics topic is presented on two considerations, namely seeing possible applications in teaching and as a point of departure in the mathematics process; and (3) self-developed models, this activity plays a role as a bridge of informal knowledge and formal mathematics **(Gravemeijer, 1994)**. Besides referring to these three principles, RME also has five characteristics, namely: (1) using a contextual problem that is realistic, (2) using the model, (3) using student's construction, (4) interactivity, and (5) intertwinement **(Wijaya, 2012)**. Mathematics is as a human activity so that principally is a situation where students are given the opportunity to rediscover the mathematical ideas to construct their own of realistic problems which given **(Shoimin, 2014)**. Teachers only act as a facilitator and motivator for the students in solving realistic problems are given, the rest of the students who actively interact with his friends to reinvent the idea or concept of mathematics.

In addition to using RME, ~~in~~ mathematics can also use Means Ends Analysis (MEA). Mathematics learning that uses MEA bases on heuristic problems **(Ngalimun, 2014)**. Means is "way", End is "purpose", and Analysis is "to analyze or investigate systematically". Thus, the MEA could be interpreted as a strategy to analyze the problem through a variety of ways to achieve the desired end (Huda, 2013). Students are given everyday problems experienced by students. Of that problem, students must separate the known issues with the things asked or the goal to be achieved. Looking for the relationship between things known with things asked and then further student's analytical skills will be developed to determine alternative solutions to solve the problem. Before the students solve the given problem, the teacher provides early knowledge of the mathematical concepts that students can identify the differences between the known issues with the goal to be achieved.

METHODS

This study used is a quasi-experimental method with non-equivalent control group design. The study design is presented in Table 1.

Table 1. Study Design

Group	Treatment	Post-Test
Experiment 1	X_1	Y_1
Experiment 2	X_2	Y_2

Information:

X_1 = Realistic Mathematic Education (RME)

X_2 = Means Ends Analysis (MEA)

Y_1 = The Student's Mathematics Achievement by using *RME* treatment

Y_2 = The Student's Mathematics Achievement by using *MEA* treatment

This research was conducted in SDN Kembangan Selatan 01 Pagi in the even semester of the academic year 2015/2016. Participants of this study are the fourth-grade students which were selected by cluster sampling, due to the characteristics of the population that cannot be done through individual randomization, then the sample collection based on population areas that have been set. The research sample are class IV A as the first experimental group taught by using RME with 32 students and class IV B as the second experimental group taught by using MEA with 33 students.

The data collection technique in this study is a written test. The written test carried out after both the experimental group were given treatment. Before the test was administered in the study, face and content validity were confirmed by consulting to experts (i.e. two doctorate lecturers in mathematics education and one elementary school teacher who is experienced). Thereafter, the test evaluated to determine level of difficulty,

discriminant index and reliability. The test of reliability using Cronbach alpha with threshold measure above 0.70 as adequate measure **(Cortina, 1993; George & Mallery, 2005)**. The result of the six questions that tested contained 5 questions that declared valid and reliable. There is one question that is not valid causes there's indicator being lost, in order for this indicator can still be tested, the researcher made improvements by asking the opinion of experts.

The data of mathematics achievement obtained from both the experimental class were analyzed to test the hypothesis. Before testing the hypothesis by t-test analysis, the first thing is to do analysis by prerequisite tests. Analysis prerequisite tests covering normality test with Lilliefors formula and homogeneity of variance with Fisher formula. Normality of data distribution by testing criteria normal distribution of data if $L_{observation} < L_{table}$. Test of homogeneity of variance with the data testing criteria have the same variance (homogeneous) if $F_{observation} < F_{table}$ at significance level (α) = 0.05.

FINDINGS AND DISCUSSION

The data obtained from both groups after being given the treatments were analyzed with descriptive statistical techniques to determine the average, variance and standard deviation. Based on the analysis of the data from students' mathematics achievement is done so it can be determined the distribution of the data which can be seen in Table 2.

Table 2. Summary of Students' Mathematic Achievement Data

	Experimental Group 1	Experimental Group 2
Mean ($\overline{X_t}$)	82.406	74.212
Variance (S_i^2)	265.410	197,047
Standard Deviation (SD)	16,291	14,037
Data (n_i)	32	33

Based on Table 2, it can be seen that there are differences in the average scores of mathematics achievement of both the experimental group, but to determine whether there are significant differences between the experimental group 1 taught by Realistic Mathematic Education (RME) and the experimental group 2 taught by Means Ends Analysis (MEA), it is necessary to test the hypothesis.

The results of the analysis of normality tests indicate that the set of data for the two groups representing populations with normal distribution. This is shown by $L_{observation} = 0.1401 < 0.1566 = L_{table}$ for group 1 and $L_{observation} = 0.0717 < 0.1543 = L_{table}$ for group 2. Results of analysis of homogeneity test from variance the both experimental group obtained $F_{observation}$ value is 1.347. While the value of F_{table} with the numerator *df* = 31 and the denominator *df* = 32 as well as the significance level α = 0.05 is 1.814. This means $F_{observation} < F_{table}$ that is $F_{observation}$ = 1.347 < 1.814 = F_{table}, it can be concluded that H_0 is accepted so variance of both groups is homogeneous.

Hypothesis testing using statistical parametric with t-test was polled using variance formula. Criteria testing H_0 is rejected if $t_{observation} > t_{table}$ and H_0 is accepted if $t_{observation} < t_{table}$ at significance level α = 0.05 and $df = n_1 + n_2 - 2$. Summary of the *t*-test results are presented in Table 3.

Table 3. Summary of T-Test Results

Group	$\overline{X}$	S^2	n	*df*	$t_{observation}$	t_{table}	Status
Experiment 1	82.406	265.410	32	63	2.174	1.999	H$_0$ rejected
Experiment 2	74.212	197.047	33				

Based on Table 3, the hypothesis testing results obtained $t_{observation}$= 2.174 > 1.999 = t_{table} so H_0 is rejected. This proves that there is a difference in students' mathematics achievement by using RME and MEA. The significant difference refers to the average value of student's mathematics achievement, experimental group 1 taught by RME, to wit 82.406 which is higher than experimental group 2 taught by MEA, to wit 74.212. The existence of these differences indicates that students in classes taught by RME gains more mastery on the subject than students in classes taught by MEA.

At the time of the experiment in each class, I found that the response of students in the class RME were more enthusiastic than in the classroom MEA. Several contributing factors can be identified. First, the mathematical problems associated with the context of the students enabled them to understand the content more meaningfully, especially when aided by concrete objects. Starting with realistic problems made students more quickly connects an explanation of the problem situated with their real experiences and provide opportunities for them to use previous experiences **(Gravemeijer & Doorman, 1999; Purwanto, 2010)**. Learning would be more meaningful if the students' own experience "what they learned, not" just know "that **(Purnomo, 2011)**. Concepts and ideas that are formed by "own experience" what they learned are more durable in the minds of students rather than the students who only know of their teachers only. In **Wijaya (2012)**, Freudenthal stated that the student learning process will happen when knowledge being learned is meaningful. A knowledge will be meaningful for students if the learning process involves realistic problems or implemented in and with the context. Furthermore, if children learn mathematics separately from their daily experiences, then they will quickly forget and would not apply it.

The second factor, the students are very enthusiastic to solve problems in the group by way of their own, so arising the competitiveness in order to be more superior than the other group. This makes students more diligent in solving a given problem and inflict of pleasure in doing mathematics **(Purwanto, 2010)**. The third factor, namely teachers only act as a facilitator by providing instruction/advice as needed, motivate students to complete a given problem by asking some guiding questions. The rest of the students seeks out and find their own way to solve the realistic problems in order to obtain his own knowledge. Knowledge cannot be moved with just scheme to scheme from a teacher to students. Each student must build the scheme in its scheme respectively **(Purnomo, 2011)**.

The fourth factor, namely the learning process becomes more alive and active because students who many contribute during the learning process, whether it is through discussion with the group itself, question and answer with the teacher, or presented the results of the discussion. As expressed **(Purnomo, 2011),** that active learning requires students regarded as subjects rather than objects so that active students, active teachers. This is the principle of mathematics as a human activity, namely the process of rediscovery. Students are given the opportunity to rediscover the ideas of mathematics to construct the realistic problems that were given with the guidance of the teacher **(Purnomo et al., 2016)**. Use of ideas or contributions of these students as an effort to enable students through the optimization of the interaction between students and students, between teachers and students and between students and learning resources **(Shoimin, 2014)**.

Unlike the case with students who are taught by Means Ends Analysis (MEA), although in the learning process using the same problems related to the daily lives of students, but the responses given during the learning process is different. Teacher explains beforehand about the fractions material so that they can gain early knowledge to solve the problems given. Shortage of students' understanding on how to solve new problems given to each group, make the teachers do more to provide direction. This is because students have not been able to imagine concretely problem that given, although the problem is related to the

everyday world of students. Therefore, teachers are still using an illustration in order that the students were able to solve the problems given.

This study results are in line with the results of some research about Realistic Mathematic Education (RME). **Megandari (2014)** study obtained result that there are differences of students' mathematics achievement by using RME (Realistic Mathematic Education) approach and problem solving approach in SDN Perwira I Bekasi Utara. Similarly, study conducted by **Widjaja and Heck (2003)** found that: 1) teachers who no longer actively took control of everything and determine what the students do, students become more responsible in completing its tasks, 2) students try to read and follow the instructions of other students, or seek and find it themselves, 3) when working individually, some students were more persistent than others but when it works as a group, the students collaborate and cooperate, 5) students are more enthusiastic about taking lessons and do not easily get bored because the lesson in the classroom are more attractive, and 6) in general, students' response to the learning process with the support of ICT and RME approach is a positive.

CONCLUSION

Based on the analysis of post-test data, it showed that the average of mathematics achievement in first experimental class were higher than the average of mathematics achievement in second experimental class. Based on t-test analysis, it can be concluded that there are differences in mathematics achievement by using Realistic Mathematic Education (RME) and Means Ends Analysis (MEA). Moreover, based on consideration of the constraints and theoretical terms of the application of this research must be balanced with the situation of students which were quiet and comfortable so that discussions can take place optimally. Teachers must have the ability to motivate students in completing a given problem and have the ability to present the material that connect the subject matter with real-world problems of students and give a concrete picture so that students can more easily understand the material given, have the ability to facilitate and guide students in completing an issue about the real world. The end is that RME, proved a better application than the MEA can be applied with better again in order to provide improvement in learning mathematics.

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