MATHEMATICS EDUCATION MODEL IN INDONESIA THROUGH INQUIRY-BASED REALISTIC MATHEMATICS EDUCATION APPROACH TO IMPROVE CHARACTER

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ABSTRACT

Mathematics education in Indonesia nowadays does not entirely orient toward the values that are required to be internalized. Basically, Mathematics education is sought to improve a complete character, an individual who internalizes symbolic, empiric, aesthetic, ethic, sinnoethic, and synoptic values. These values control his behaviour. If an individual cannot internalize these values during the learning process, he will become an incomplete character; therefore, there will be problems with his behaviour.

This research is aimed to: (1). Describe the implementation of mathematics education conducted by teachers. (2). Produce mathematics education model through the approach of Inquiry-based Realistic Mathematics Education, to improve students' character. The employed research methods were research and development, i.e. the research that is organized to arrange a new product or procedure that has been tested systematically, examined carefully, and fixed completely to fulfil certain standards. The sample in this research involved 128 students; 64 students from class of XI Science 1 and 2 of Jatisrono State Senior High School 1, and 64 students from class of XI Science 1 and 2 of Girimarto State Senior High School 1. Data analysis used in this research was descriptive analysis.

The results of the research reveal: (1). Implementation of mathematics education done by teachers of the senior high schools in Wonogiri depicts that teacher still dominates learning process. Consequently, students tend to be passive. It reflects that the values of cultural and national character strengthening national character and identity have not been integrated in Mathematics education. (2). PEMATERI is basically a cooperative learning model that collaborates inquiry-based realistic mathematics education approach as an effort to improve students' character. The implantation of character values in mathematics is integrated in Syllabus and Lesson Plan, and then, it is implemented in Mathematics education.

Keywords: Learning model, Mathematics, Character

A. INTRODUCTION

Character education through mathematics education can be performed based on the suggested recommendation, which starts from the values mapping steps to the teaching-learning activity in correspond to the developed syllabus and lesson plans. Analysed from the point of view of mathematics education, the poor character of students in learning process is caused by the following reasons: first, nowadays, the goals and mathematics education process are not appropriate. Second, mathematics education practice is not balanced in improving mind and heart, *fikr* and *dzikr*. Third, mathematics education is no longer oriented to the values expected be internalized. Basically, mathematics education is aimed to improve one's entire characteristic. Fourth, mathematics practice and learning does not treasure humanity.

From the observation conducted by researcher, there are five (5) items that should be mended, they are: firstly, teacher should focus on students' comprehensiveness on the learning material that has been assigned in the curriculum and based on the specific time allotment. Secondly, students usually feel under pressure since they are forced to master the knowledge and devour all information from teachers without a chance to make a critical contemplation/ reflection. Thirdly, there is only one way communication between teacher and student (teacher-centered) and the utilized teaching method is only a variety of lecturing methods. Fourthly, students do not eager to ask, to express their creative and innovative ideas and they do not have independency in learning. In other word, the learning process is not interesting. Fifthly, the implementation of character education through mathematics education is very low.

Efforts from education unit and educators, using the terms of conditioning, shaping and producing the characters of students, is focused on directing mathematics education process to contribute to the character education. It is now widely-known as *Realistic Mathematics Education* (*RME*) that was pioneered by Dutch and then adapted to *Pendidikan Matematika Realistik Indonesia (PMRI)* or Realistic Mathematics Education of Indonesia. Philosophical foundation of RME that was further adapted by PMRI is formulated based on Freudenthal theory concerning mathematics, they are: (1) *mathematics must be connected to reality*, and (2) *mathematics should be seen as a human activity* (Prabowo and Sidi, 2010:173). It means that mathematics should be intertwined with the reality nearby, familiar, experienced, and relevant to the actual life of the students who are learning mathematics.

Realistic Mathematics Education approach is one of mathematics education approaches that use contextual problems as the starting point of the learning process. Beside RME, there is also other mathematics education approaches or models that apply context or contextual problems, this is what they call *Contextual Teaching and Learning (CTL)*. Meanwhile, Sears & Hearsh (2001; 1-4), described *Contextual Teaching and Learning (CTL)* as an educational theory with these characteristics:

> *The teaching enables learning in which pupils employ their academic understanding and abilities in a variety of in-and out-of-school contexts to solve simulated or real-world problems. The learning is characterized as problem based, self-regulated, occurring in a variety of contexts including community and work sites, involving teams or learning groups, and responsive to a host of diverse learner needs and interests. Teaching and learning emphasizes higher-level thinking, knowledge transfer, and collection, analysis, and synthesis of information and data from multiple*

sources and viewpoints. The teaching-and-learning includes authentic assessment that is derived from multiple sources and is ongoing and blended in the instruction.

Based on the explanations above, it can be inferred that *RME* and *CTL* have similarities, especially in using contextual problems. However, there are differences in the matter of contextual function. In *RME*, contextual problems that are used should be realistic, which means, the problem should be easily portrayed in students' life, and it is specially functioned as tool for *re-invention*, or to shape model, even though, further, in other part of learning process, there will be discussion about contextual problem as an example of mathematics implementation.

In Mathematics Education, *RME*'s strength lies on the mathematics concept. From this aspect, *RME* has superiority in the approach, when it is compared to other methods. It is because the realistic approach uses mathematical process, both horizontal and vertical. While, other approaches develop only the horizontal mathematics skill (empiristic approach) or vertical mathematics skill (structuralistic approach), and even without mathematics skill at all (mechanistic approach).

By integrating the advantages of a variety of learning approaches, the advantage of RME is increasingly visible.

The purposes of Mathematics are (1) Gaining attitude to respect the meaning of Mathematics in life, that is curiosity, care and interest to find problem solutions. (2) Solving the problems including the capability of understanding problems, designing models for Mathematics, completing models and explaining obtained solutions (Depdiknas 2006a); then researcher combined this method with *inquiry* method to improve students' character. Inquiry technique is a series of methods to emphasize how to think critically, analytically and dialectically to discover answers from the questioning problems (Wina Senjaya 2008).

Based on the research conducted in Harvard University of United States (Ali Ibrahim Akbar, 2000), apparently an individual's success is not determined by knowledge and technical ability (*hard skill*), but more by the ability to control themselves and other people (*soft skill*). This research explains that success is determined by 20% hard skill and 80% soft skill. Even the most successful people in the world succeed because they have more *soft skills* than *hard skills*. This indicates that the quality of student character education is highly required to enhance. The most essential thing is to include Mathematics in the national plan of implementing character education as a tool to measure and determine relevant characteristic values in formative and summative assessments by integrating them in the Mathematics teaching-learning process observed using affective activities observation sheet.

Therefore, innovation and renewal in Mathematics teaching methods are required to describe the phenomenon of Mathematics learning in senior high schools using Inquiry-based Realistic Mathematics Education approach to enhance students' character in order to create students with competitive and comparative abilities in correspond to the national standard quality. This research is further expected to create a new learning method for Mathematics through Inquiry-based Realistic Mathematics Education to improve senior high school students' character.

This PEMATERI model is expected to inspire the teachers to develop students' cognitive, psychomotoric and affective abilities that contribute to the enhancement of their character values by

internalizing them towards the students. Therefore, this learning method namely PEMATERI is expected to give contribution to increase the quality of Mathematics learning as well as quality of the students as individuals who are faithful and righteous to the Almighty God, and eventually, it is expected to enhance the quality of Mathematics learning in general and students' character values in specific.

B. METHOD

The objective of this Research & Development (R&D) type of research is to design and develop a new and better quality model, in the form of manufacturing process from a series of elements arranged together to produce a certain product, and to test the effectiveness of the product (Saigon 2013:297).

Correspondingly with Putra (2012: 67), he explains that the Research and Development (R&D) is a method of research aimed at or directed to find, discover, formulate, refine, develop, produce, and test the effectiveness of products, models, methods / strategies / techniques, services , certain better, new, effective, efficient, productive and meaningful procedures. R&D is directed to seek and find a product related to the effectiveness, efficiency, and productivity. R&D emphasizes on useful or beneficial products in various forms of expansions and innovations of the existing forms. The sample in this study involved 128 students; 64 students from class of XI Science 1 and 2 of Jatisrono State Senior High School 1, and 64 students from class of XI Science 1 and 2 of Girimarto State Senior High School 1. According to Budiyono (2004: 47), questionnaire method is a data collection method through submission of written questions to the subject of the research, respondents, or other data sources and the answers are given in writing. The data analysis method of this study is descriptive analysis.

Furthur according to *Hyeong-Ohk Bae and friends:*

"We present a mathematical model for stock market volatility flocking. Our proposed model consists of geometric Brownian motions with time-varying volatilities coupled with Cucker–Smale (C–S) flocking and regime switching mechanisms. For all-to-all interactions, we assume that all assets' volatilities are coupled to each other with a constant interaction weight, and we show that the common volatility emerges asymptotically and discuss its financial applications. We also provide several numerical simulations and compare them to existing analytical results.

Based on the statement above, it can be concluded that mathematical model can be one of analytical that has beneficial.

C. RESULT

The analysis activity of the problems and the discoveries obtained through field study in Wonogiri State Senior High School were used to plan further activities in solving the encountered problems in Mathematics learning process and increase students' characters. The mentioned activities were utilized as information in order to obtain a picture of the need to develop models of learning Mathematics using PEMATERI to improve the students character. In conducting the need analysis, researchers carried out the following techniques: (first) Interview with Drs. Sutrisno, M.Pd, Tinuk Triyana, S.Pd. M. Ing, Eko Nuryanto, S.Pd, Ida, M.Si, Nina Conscience, S.Pd, Drs. Warsino, through *Focus Group Discussion (FGD)*. (Second) Consultation with Drs. Setyawan, M.Pd and Drs. Sularno, M.Sc. as supervisors of education, (Third) Observation.

Through interviews, it was expected to obtain information directly from the educational functionaries and high-school managers regarding the need to develop PEMATERI as mathematics learning model to improve students' character. The raised questions were as follows: (1) Is there any existing model of learning mathematics? (2) If yes, how is the quality of mathematics teaching model in high school and what are the effects? (3) Do we extremely need a new model of learning mathematics to improve students' character? Through those initial information gathering techniques, feedbacks were expected to gain directly from the users of the learning models, including: the Department of Education, school principals, mathematics teachers, and students.

Moreover, Turanoya Olga said that

> "We study a reaction–diffusion equation with a nonlocal reaction term that models a population with variable motility. We establish a global supremum bound for solutions of the equation. We investigate the asymptotic (long-time and long-range) behavior of the population. We perform a certain rescaling and prove that solutions of the rescaled problem converge locally uniformly to zero in a certain region and stay positive (in some sense) in another region. These regions are determined by two viscosity solutions of a related Hamilton–Jacobi equation.

It mean that there was solution provide and has the positive impact to the models

D. DISCUSSION

The development stage includes continuous validation, revision and testing of the learning model draft. The validation of the model draft was performed by 3 experts; they were Mathematics education expert, character education expert, technology education expert, and education practitioner. In the model development stage, the researcher also conducted *Focus Group Discussion (FGD)* with a colleague, a Mathematics teacher. The results of these activities were the models that were ready to be applied in the field.

The filed testing stage includes: preliminary field testing, main product revision, main field testing, and operational product revision. The preliminary field testing of the model design was conducted by implementing experimental methods *(Single one short Case Study)*. After revision, a broader test was carried out by applying experimental methods (one group pre-test and post-test) to acquire effective and efficient models.

The activities conducted in the development stage of Mathematics learning model through PEMATERI to enhance students' character are as follows:

a. Consultation with expert

This stage produced in this stage was the draft model and the device 1 including the PEMATERI learning model and mathematics education instruments and other instruments to collect the data of the PEMATERI learning model effectiveness.

Activities at this stage comprise: (1) Establishing the procedures including learning stage procedures that is expected to enhance the student's characters; (2) Determining the learning environment and norms applied in learning process, such as the teacher's role and the student's activities when its process with the PEMATERI model is running; (3) Providing an overview to the teacher on how to intervent the students, to view and to respond their attitudes / activities during learning process; (4) Determining the support system consisting of terms / conditions needed in order to implement the learning model.

Based on the specific criteria of defined products, researchers developed and wrote a preliminary draft of mathematic education with PEMATERI model and its instruments consisting of: syllabus and lesson plan (RPP) under the competence standard "Using the concept of limit of a function and derivative function in problem solving", and a Guide Book of Teaching in annex 8 and 9. The result of the initial draft was consulted to a mathematics and character education specialist. This activity resulted in the draft of model development and Math education instruments based on charcter education (PEMATERI), then it was called as the draft model and devices 1.

b. Evaluation by Expert

The draft model and the device 1 produced will then be examined with the evaluation conducted by an expert of subjects or contents. They are the expert in mathematics education, character education, technology education, and practitioners. This activity was aimed to determine whether the draft model and the device 1 supporting the learning process can be used properly by teachers and students. They are evaluated and revised repeatedly to launch the better draft model and devices 2.

c. Design Validation

Learning model validation is the attempt to obtain high validity learning model. The activities were the validation to the guidelines draft or the strategy of learning model, and the instruments of learning design and research which will be used. Validation was undergone with validation test by an expert.

The validation test by an experts was performed to the conceptual validation of the initial draft of the designing learning model. In a conceptual validation model, the first step was asking for expert judgment and practitioners about the feasibility of the initial draft of learning model concept that had been developed.

The expert of model and learning instrument was Prof. Dr. Abdul Gafur, M.Sc., a lecturer at the Graduate Program majoring in Educational Technology, UNY Yogyakarta. The mathematics expert was Dr. Iwan Junaedi, M.Pd., a professor and chairman of the Natural Sciences program UNNES in Semarang. The expert of character instrument was Prof. Dr. Samsi Haryanto, M.Pd., a professor of graduate programs at UNS Surakarta.

In designing validation activities, researchers needed the advice given by experts to make improvements. Researchers used the instruments in the form of validation sheet submitted to the validator. The tests were then analysed, and there were three possible reasons: 1) If valid without revision, the next activity is the field trials, 2) If valid with revision, a minor revision must be made which then

produces a model draft. Having obtained a draft of the model, field testing is then conducted, 3) if it is not valid, and then major revision needs to be done to achieve model draft.

d. Design Revision

At this stage, the learning model that is being developed after the validation is said to meet the category of effectiveness if the objectives expected from the implementation of the learning is achieved. Indicators of the effectiveness of Mathematics teaching model being developed can be said to be effective if it meets three criteria, namely: (1) the quality of the learning process in class increases; (2) the students' character improves; and (3) responses from students and teachers are positive towards PEMATERI learning model implementation in class. The result validated by the expert that has been revised creates a draft of learning model ready to be tested.

e. Product test

The main activities at this stage of development are related to the stage of testing, evaluating, and revising the developing version of PEMATERI learning model. This phase focused on the activities of field trials (empirical validation) of the learning model draft, as a follow-up concept of validation made by experts and practitioners. Product trials of the learning model being developed were aimed at finding out to which extent the learning model met the criteria of being valid and effective. The validity of PEMATERI learning model was determined by the feedback score data from the experts / practitioners obtained through questionnaire, performed by calculating the average values of the indicators and the value aspects of each expert / practitioner.

The following are the syntaxes of learning model based on the stages and phases of Mathematics education in inquiry-based realistic mathematics education approach.

1) Introduction

The introductory stage is the first stage for teachers to prepare the class and students to lead in to PEMATERI learning model. This activity is done by controlling the classroom, checking the attendance list and students' readiness, and preparing teaching tools and materials. Apperception (introductory activity) in this PEMATERI learning model is a very important step because teacher informs and explains the learning model that is going to conduct; they are: (a) Mathematics learning model in high school class of XI Science, (b) Applying PEMATERI learning model, and (c) implanting character values related to the materials for Mathematics Learning.

2) Main stage

In this stage, there are three important activities that must be done; they are:

a) Exploration

In this stage, teacher gives a chance for students to make creation and improvement on their thought regarding the concept of "using the concept of limit of a function and derivative function in solving problems." Teacher guides or facilitates students to straighten students' way of thinking, just in case they have a very different point of view to the concept." By using problems and situation of the school, it can be imagined that students and teacher are asked to look back or reconstruct concept and principle "using the concept of limit of a function and derivative function in solving problems." Next, it can be

done through group discussion (Portfolio group) and question and answer; teacher attempts to contribute to students' experience and implant character values.

b) Elaboration

Elaboration stage is an advanced stage of exploration. Through some researches and group discussions, they carefully examine materials and take character values that can be improved and made as models. Students are involved interactively, explain, and give some reasons to solve problems contextually (solution obtained) by finding the solution by themselves, understanding their friends' work, explaining in class discussion concerning their attitude toward their friends' solution, asking the alternatives in solving problems, and reflecting those solutions. Mathematics structures and concepts obtained from this realistic problem solving is directed to the intertwining of divisions of Derivative Functions.

After a while, teacher gives opportunity for each group to present their work (portfolio), while other groups give their opinions.

c) Confirmation

After they present their work, evaluation is conducted through games/tournaments. In this stage, students already have enough information to start improving their portfolio. Teacher divides the class into portfolio groups. By re-examining assignment and the specification of the portfolio, the students of each group are expected to have understood the expected result of the final assignment. Teacher guides each group to read and discuss step by step based on their assignment.

Information gathered by the teams usually gives more benefit for all portfolio groups. To assure that each group has been well-informed, teacher asks each group to come forward. Each group should read the questions and explanations during the portfolio presentation. After the presenting group reads the questions, other students give relevant information that they have gathered to the presenting group.

Written information that might be important for more than one group can be used and given to each group to complete their assignments, as determined in students' textbook. The assessment of the portfolio assignment is considered the result of group evaluation. From all groups' scores, it can be listed the group with highest and the lowest score. From this data, there will be winners, the first, second and third winners in PEMATERI learning model.

3) Closing

Teacher gives reward to the champions or winning groups. Teacher gives material reinforcement and character values, and teacher informs the evaluation related to material "using the concept of limit of a function and derivative function in solving problems" and character values.

CONCLUSION

Senior high school Mathematics education in Wonogiri Regency focuses on the accomplishment of a number of learning materials that have been determined in the curriculum with the provided time allotment. Students feel forced to master knowledge and devour all information from the teachers without any chance to think/contemplate critically. Communication occurring in the learning process is only one way (*teacher-centered*) and the learning process uses a variety of lecturing methods. Students do not eager to ask, express

creative and innovative ideas, and they do not have independency in learning. In other words, the learning process is not interesting and the implementation of character education through Mathematics is very low.

The implementation of PEMATERI learning model is planned through steps that put students' activity as the main focus and reduce teacher's domination. Teacher tends to act as designer, moderator, and facilitator. As designer, the role of the teacher is to design the steps for implementing PEMATERI learning model that highlights students' activities and reduces teacher's domination. Moderator is one who directs students to learn materials that will be reviewed in discussion, both group and class discussions. Facilitator is one who bridges students in discussion and games. Related to the value learning, it is important to implant basic values that become the core values in character education related to Mathematics Education, such as: religious value, patriotism, love of the homeland, a willingness to sacrifice, critical value, creativity, honesty, independence, and hard work.

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