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DIFFUSION MODEL OF THE MANIPULATIVES OF THE PRIMARY EDUCATION INNOVATIVE MATHEMATICS LEARNING

Isti Hidayah[1], Sugiarto[2]

[1] Mathematics Education Study Program Semarang State University Indonesia
[2] Mathematics Education Study Program Semarang State University Indonesia

ABSTRACT

According to the research roadmap which is currently followed by the researcher, several new findings have been found related to the primary education innovative mathematics learning. The findings are related to the manipulative teaching aid, hereinafter called the manipulatives. The practical advantage of the result of this research is the ability of the teachers to implement the manipulatives-based innovative learning. For that purpose, we need a diffusion model of the new findings so that they can be adopted by teachers in the implementation of innovative mathematics learning. Based on the analysis of the current researches, the diffusion model should take place through the teacher working group (KKG) or subject-based teacher forum (MGMP) and through the industry of the educative teaching aid. The diffusion model is not only expected to accelerate the adoption process but also to give chance for the sustainability of the adoption process. It because the diffusion is implemented based on the target need and based on the community empowerment principle.

Keywords: the manipulatives, diffusion model, target need, and community empowerment

INTRODUCTION

Various education researches, particularly in mathematics learning innovation for primary education, have been conducted by higher education institution (LPTK). However, there is no guarantee that the innovation of the research result could be followed up by the application of the result. The teachers can not automatically adopt an innovation, while the school authorization demands changes following the development of sciences and technology so that the school could fulfill the demand of the stakeholder and could maintain the quality of the school. A successful organization is the one which could maintain the flexibility and continuously improve its quality. Teacher as the main component of the school organization is the main factor of the school quality (Robbins, 2007). According to Rogers (1995), one of the factors affecting the diffusion of the innovation is the agent of change. An agent of change plays a role to foster attitude of self-regeneration for himself and the others. Nevertheless, we can not say that the only factor affecting the adoption process is teacher. The adoption process might not happen because of the process of diffusion is not optimized (not understandable, different competence to understand), or because of the problem in the process of adoption itself.

Mathematics learning media, hereinafter called the manipulative, is important for the students of primary education (elementary school and junior high school). The fact shows that the students of elementary school and early junior high school in Indonesia generally are in the level of operational concrete thinking stage (Piaget), while the mathematics objects are abstract. Besides assisting students to find concepts and principles, the manipulatives could help students to work in problem solving. Kelly (2006) said, "The term, manipulative, will be defined as any tangible object, tool, model, or mechanism that may be used to clearly demonstrate a depth of understanding, while problem solving, about a specified mathematical topic or topics". Her article discusses a process of problem solving in elementary school which focused on how students used the manipulatives to do the mathematics tasks. The current researches show that teachers need to teach and to examine the students' work by instruments which enable teachers to see what students really understand. It is not merely the correct or false answer but also the thinking process. The problem raised is how the diffusion model of the manipulatives in the primary education innovative mathematics learning would be in order to be applied in mathematics learning.

METHODS

This article was written by analyzing the result of related researches conducted by writer to answer the formulated problem. The result is the hypothetical diffusion model of the manipulatives in the primary education innovative mathematics learning. The analysis including: (1) the use of the teacher working group (KKG) and the subject-based teacher forum (MGMP) model as a mean of teacher professional development; (2) the preparation of teacher candidate in the teacher education institution; (3) the development of manipulatives in the primary education mathematics learning with the industry. From the analysis, we conducted discussion and then draw conclusion and recommendation.

RESULT AND DISCUSSION

Teacher working group (KKG) is a forum of professional development for elementary school teachers organized in a group of school with a purpose to improve the education quality, while the subject-based teacher forum is the KKG forum for the high school teacher. One of the functions of KKG and MGMP is to solve problems faced by teacher in the learning. The other activities conducted in the KKG/MGMP forum are: (1) testing new learning activities, (2) conducting peer teaching and discussing the result, (3) visiting schools for comparative study purpose, (4) evaluating students' work, and (5) analyzing textbooks. In the Standard of KKG Development (Direktorat Profesi Pendidik, 2008), it is explained that the purposes of KKG are: widen the teachers' knowledge in many things, particularly to master the substantive material, to make syllabus and handouts, to know the learning strategy, to utilize the learning equipment, and to improve the skill of manipulatives use. The fact shows that the function of KKG has not been optimized. The condition of the supporting components of KKG shows that: the availability of trainer from higher institutions (lecturer) is only 21.5%, and the availability of equipment is still low (scored 3.34 of maximum 5). The KKG model could optimize the work of KKG to be qualified and independent. This model of KKG is supposed to be able to create link with the teacher education institution, to sustain the quality improvement process, and to empower its members (Hidayah, 2011). It also happens in MGMP, the result of research conducted by Hidayah, et al (2011) states that the empowerment of teachers is appropriate to be conducted through the MGMP, and this process could also optimize the work of MGMP. Besides the empowerment of teachers, the other factor affecting the teachers' success in learning is the support from external party, namely the teacher education institution (LPTK).

The challenge for the future teachers brings consequences that the implementation of education quality management should be paid attention. The improvement of school curriculum is also become the reference of the curriculum improvement in the teacher education institution. The latest curriculum at school is the 2013 Curriculum, while the curriculum in the mathematics study program, Mathematics and Natural Sciences Faculty Semarang State University (one of LPTK in Indonesia) is the 2012 Curriculum and improved to be the 2015 Curriculum. The main competences among the graduate competences are: (1) being able to master the mathematics material and to apply them in smart and democratic ways in mathematics education context; (2) being able to conduct mathematics learning professionally, honestly, and smartly, by using the innovative learning model, to use the environment-friendly modern technology, and to set a student-centered democratic learning; (3) being able to conduct mathematics workshop on using innovative approach, environment-friendly modern technology, and upholding tolerant and responsible values within the learning; (4) being able to give guidance in the smart, religious, tolerant, and responsible mathematics learning (Program Studi Pendidikan Matematika, 2012). Besides, in order to face the global challenge, teachers are supposed to always improve their competences (Sudrajat, 2007).

The hope for the future teachers has been an important part to prepare teacher candidate within the teacher education institution. The education study program should not only focus on the knowledge and skill of the teacher candidate. The preparation should also concern in the pedagogical, professional, personal, and social competences (Hidayah, 2014). The same thing quoted in another source, "Enhancing ethics concerning teaching practice is one of the most important issues in teacher education. All teachers need to improve their ethical sense for maintaining professional standards in teaching and doing research as well as monitoring and guiding students' ethical behaviours. It is crucial for pre-service teachers to develop their ethical sense during learning in teacher institutions" (Kruea-In, 2015). The teacher education program should give chance for the improvement of professional knowledge and skill for the pre-service teachers (Kilic, 2015). Thus, the phenomena related to the teacher quality is important factor as the analysis source to prepare the learning for teacher candidate.

Research of Hidayah et al (2015) about the development and marketing of school mathematics learning media aimed to find the model of production process of the teaching aid of mathematics learning as a result of synergy between the higher education institution and the children toys industry. The production aimed to produce manipulatives suitable with the characteristics of students, mathematics learning, and the curriculum. The manipulative product as a result of this research has better quality compared with the hand-made media from the mathematics laboratory. The production stages are: re-mapping of the manipulatives based on the current curriculum, design by the researcher team, socialization towards the industry and workers, design application with assistance, evaluation and improvement, and then

finishing. There are four groups of products, namely: manipulatives of planar geometry with eva foam material; manipulatives of spatial geometry with MDF material, manipulatives of cylinder, cone and sphere volume, cylinder; cone, and sphere surface area with plastic material; and manipulatives of algebra and arithmetic with wood material. The stage of preparation of tool and material of planar geometry manipulatives are: making cutter, making cutter and the printing equipment-material preparation (eva foam, ink, and eva foam glue), and packaging. The stage of preparation of tool and material of spatial geometry manipulatives are: preparation of material (wood and MDF) and making pattern. The preparation stage of manipulatives of cylinder, cone and sphere volume are: designing completed with the prototype and size, making the moulding, preparing the blow machine, preparing the plastic material, and then experimenting the sample. The preparation stage of manipulatives with wood/MDF material are: cutting, arranging, refining, finishing, and packaging. The production stage of planar geometry manipulatives are: cutting, classifying to each group, printing, finishing, and temporary packaging. The production stage of surface area manipulatives are: cutting, classifying, stamping the indicator of face area (using color), finishing, and temporary packaging. The production stage of manipulatives of cylinder, cone, and sphere volume are: production by operating blow machine using the designed moulding.

The production of algebra and arithmetic manipulatives are relative flawless, though it is a diversification of the industrial product. It because the manipulatives are the modification of the current industrial product of educative teaching aid accommodating the mathematics concept and principle in order to be suitable with the purpose of learning. Beside that the product is smooth, the production time is faster. Each group of product with the different material is produced by different machine or tool as well as requiring different material and preparation stage. The availability of the manipulative teaching aid will support the implementation of the innovative mathematics learning. The important factor after the industrial process is the marketing process. The existence of innovation and creativity of higher education applied in the industrial product diversification will be perfect if it is equipped by promotion which could improve the consumer awareness towards the manipulatives for mathematics learning. Navratilova (2015) explains that the campaign of small and middle industries marketing has been a strong and competitive quality in local market. It depends on the final product enter the market itself. The massive promotion strategy brings a competitive advantage for the small and middle industries. The synergy of higher education institution and the industry in the production and marketing process will accelerate and widen the diffusion and adoption of the innovation mathematics education manipulative product.

The success of the promotion and marketing is etermined by the adoption of innovation (new findings) by the stakeholder. Promotion is the diffusion effort of the innovation towards the user (client). One of the determinant factors of the success of agent of change is the effort to change with the client. The generalization result of several researched shows that the success of agent of change has a positive relation with the effort. The success indicator is measured by the innovation adopted by the client. The agent of change would be more successful if they focus on the institution they work. There three reasons supporting the argument: (1) if they have orientation focus on the client then they could have feedback, (2) they could mingle with the client and get trust, (3) the program is run based on the need of the client (Rogers, 1995). The sustainability of adoption will have chance if the adoption process is done with the community empowerment. The diffusion shall be conducted by using appropriate approach based on the need and potential of the community target.

The main client of the manipulatives which will be applied at the innovative mathematics learning is teacher. While in the previous research, it is said that the percentage of the lecturer attendance in the KKG/MGMP meeting is low. Then, the availability of the manipulatives at school also low. Thus, enhancement of adoption of manipulatives could be reach by running the alternative diffusion model of manipulative which will be used in the innovative mathematics learning and the model would involve teacher, industry and pre-service teacher as shown in the Figure 1 below.

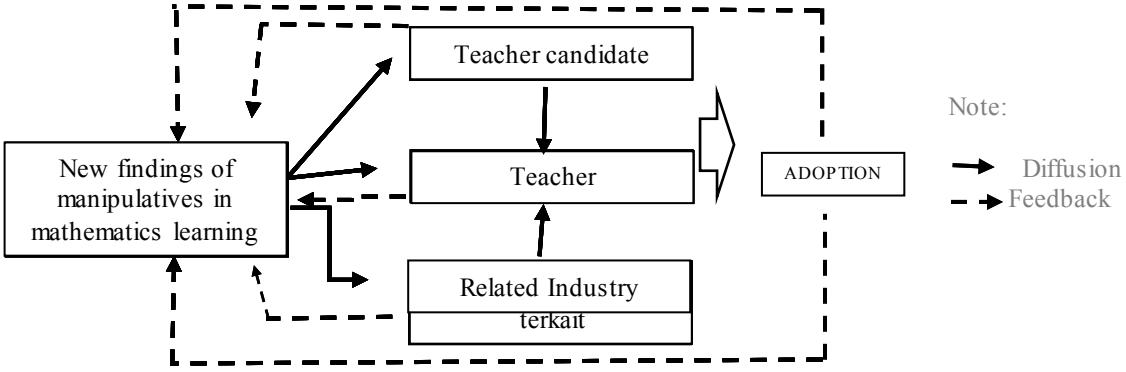

Figure 1. Scheme of Diffusion Model of Manipulatives in the Innovative Mathematics Learning

The strengthening of the teacher candidate will accelerate the adoption process of the manipulatives. The supply of manipulatives by industry will ease teacher to adopt the innovative mathematics learning. The diffusion towards the three subjects is different. For the teacher candidate, the diffusion happens by integrating the findings and the lecturing material as conducted by Hidayah (2014). For the teacher, the diffusion happens through the KKG and MGMP forum by creating link with the education institution (the attendance of lecturer as an agent of change), and by improving the sustainable quality (Hidayah, 2011, 2012). This diffusion has advantages because the teachers meet the agent of change face to face and they could see the demonstration of the findings. Besides, the promotion is also promising (Navratilova, 2015). Meanwhile the existence of the industry is as the supplier of the innovative product. This cooperation could empower the society through the product diversification and enhancing the market (Hidayah, 2015).

The feedback from each component gives chance for the improvement of diffusion quality in each component. It also gives chance for the adoption process to find new findings. The diffusion model enables the agent of change to understand the existence of the target so that the situation will be in a good condition.

The diffusion bu using this model could ease the agent of change effort because it uses the existing activities. For the target, the availability of the agent of change also bring advantages because they could get what they need. Thus, the model accelerate the adoption and its sustainability.

The appropriate adoption of the manipulative within the primary education innovative mathematics learning will strengthen the students competence in mastering the concepts, principles, and thinking ability to solve problems (Hidayah, 2013). Kelly (2006) also explains that the research of manipulatives year by year bring advantages not only for the teacher and parents but also the future businessman.

The alternative model of diffusion is a hypothetical model which should proceed to the research to get the empirical model. The research also aim to predict the acceptance of the product and the obstacle in the adoption process. The research could be conducted using Analisis Technology Acceptance (TAM) approach (Sherina Devi, 2014), with respondents are teacher (user), teacher candidate, and industry.

CONCLUSION AND RECOMMENDATION

The diffusion of the manipulatives for the primary education mathematics learning could be conducted in an alternative diffusion model as the hypothetical model to enable the adoption by the user. The diffusion model can be conducted through the independent KKG/MGMP forum, by strengthening the teacher candidate, and empowering the industry community by innovation as the diversification of the product. As a recommendation, the empirical testing should be equipped by the acceptance analysis of the technology towards the innovation of manipulatives in mathematics learning by using TAM approach.

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