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THE IMPLEMENTATION OF POGIL IN MATHEMATICS LEARNING PROCESS TO DEVELOP STUDENTS' COMPETENCES WITHIN CURRICULUM 2013

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Abstract

Curriculum 2013 is the newest curriculum in Indonesia which focuses on four competences. Those are religiosity, attitudes, knowledge, and skills. Those four competences are required by students in mathematics learning process within Curriculum 2013. The approach used in this curriculum is scientific approach with inquiry learning implementation. One of the learning strategies which are based on inquiry learning and suitable with Curriculum 2013 is Process Oriented Guided Inquiry Learning (POGIL). Actually, POGIL is a strategy which is based on science learning and constructivism principles, but it can be implemented in mathematics learning to develop the competences of students. In a POGIL classroom, students work in a team. The learning team constructs knowledge by working in a group with inquiry activities that has been specially designed in student worksheet. These activities can improve the students' knowledge level by focusing on concept of development. Besides, the students can also apply their knowledge in new contexts. Moreover, the students learn to rely on thinking and performing skills rather than memorizing, and also developing positive relationships with other students. This paper aims to explain how to implement POGIL in mathematics learning process to develop students' competences within Curriculum 2013. The method used in this paper is literature review. This paper will explain the theories of mathematics learning, POGIL, and competences of Curriculum 2013.

Keywords: mathematics learning, POGIL, competences of Curriculum 2013

INTRODUCTION

Education in Indonesia should be able to produce high quality graduates which have high competitiveness with other countries. Various efforts have been done by the government to improve the quality of education in Indonesia. One of the efforts which have been afforded is improving the curriculum at all levels of education. Finally, in 2013, the government published Curriculum 2013 as the recondition of Curriculum 2006.

Curriculum 2013 focuses on four competences. Those are religiosity, attitudes, knowledge, and skills. Students should have those four competences in mathematics learning which uses scientific approach with implementation of inquiry learning.

Unfortunately, many teachers of mathematics are not yet able to implement the inquiry-based learning strategies which are appropriate with Curriculum 2013. The strategy which is frequently used by the teachers in mathematics learning process is expository or conventional learning. Several studies have documented that learning in schools only generates students with a lot of knowledge, yet they are lack of attitudes and skills. Many cases such as corruptions and anarchic actions show that Indonesia society is not consistent with the religous and Pancasila values. (Suyitno, 2012).

One of the learning strategies which are based on inquiry is Process Oriented Guided Inquiry Learning (POGIL). Besides, it also can be implemented in mathematics class as an alternative way to develop students' competences within Curriculum 2013. Although POGIL is a strategy which is based on science, it contains the constructivism characteristics and principles that can be implemented in mathematics learning process to develop students' competences within Curriculum 2013.

This paper offers POGIL as one of the inquiry-based learning strategies that can be implemented in mathematics learning process to develop students' competences within Curriculum 2013. Moreover, this paper will explain how to implement POGIL in mathematics class to develop students' competences within the newest curriculum as previously mentioned.

EXPLANATION

A. Mathematics Learning

The essence of mathematics learning is that students try to solve mathematics problems meaningfully, because mathematics is not only for acquisition of the formal algorithm procedures. Skemp (1991) explains that the main ability required for mathematics is the ability to form and manipulate abstract ideas. Studying mathematics is not only related to numbers and operations, but also related to ideas, structures, and relationships which are arranged logically. So, mathematics is related to abstract concepts.

According to Bell (1978) there are four direct objects of learning mathematics. Those are fact, skill, concept, and principle. The fact is arbitrary convention in mathematics, such as symbols. Skill is the operation and procedures which are expected to be completed quickly and precisely by the students. Concept is the abstract idea that allows someone to classify whether the objects is an example of the abstract idea or not, while the principle is the most complex mathematical object that contains a series of concepts and the relationship between these concepts.

Curriculum 2013 requires that mathematics learning process should focus on the development of religiosity, attitudes, knowledge, and skills. The development of religiosity and attitudes are not only implanted through religious education, but also needs support through mathematics learning. Mathematics learning should implant the values associated with mathematics and its application explicitly either within public or social (Suyitno, 2012).

In addition, Piaget believes that for knowledge and skill, learning is an active process where the new information is accommodated into previous understood meanings or mental images. In the classroom, teachers should understand students' current understanding, then select activities that may challenge those images (Hunter in Chambers, 2008). Furthermore, the teachers should also give students an opportunity for investigating, reasoning or deciding the solution process and improving mathematics problem solving skills. If mathematics learning successfully generates students who have attitudes, knowledge, and skills, then it improves the quality of human resources in Indonesia.

B. Process Oriented Guided Inquiry Learning (POGIL)

According to Straumanis (2010), POGIL is a stemming from combination of Process Oriented (PO) and Guided Inquiry (GI) methodologies. The GI part is achieved by the usage of carefully designed learning cycle activities that guide students toward construction of their own understanding. The PO part comes from the frequent or exclusive usage of small groups.

POGIL has two broad aims i.e.: to develop content mastery through students construction of their own understanding and improve important learning skills such as information processing, oral and written communication, critical thinking, problem solving, metacognition, and assessment (Moog & Spencer, 2008).

The special characteristics of POGIL are the use of learning cycle to promote inquiry and the focus on developing process skills through the use of defined team roles. Lawson in

Moog & Spencer (2008) describe that a learning cycle consists of three phases. Those are exploration, concepts invention, and application. The learning cycle was first conceived as a guided discovery by Myron Atkins and Robert Karplus in 1962. The model was later refined and reintroduced by Robert Karplus and Herbert Thier in the late 1960s as science teaching method (Llewellyn, 2011).

A common and effective strategy for using POGIL materials is by dividing the class in groups of three or four students that works on specially designed activity worksheet. The worksheets follow the learning cycle model which contains three parts i.e.: exploration, concept invention, and application (Straumanis, 2010). Moreover, Straumanis explains that quiz becomes important thing in POGIL class. Every period (except the first class period and the period after each hour exam) begins with a three-minute quiz. The purpose of the quiz is to give the teachers some immediate feedbacks about how well the concept is learned by the students, to reinforce the concept in the students' mind and to encourage the students to do the homework before the quiz is given.

Many POGIL classrooms employ formal roles. The roles are frequently rotated in every class meeting, so that every student experiences each role and responsibility. According to Hanson (2006) and Straumanis (2010), the following are the most commonly used roles.

1) The manager; he/she actively participates, keeps the team focused on the task, distributes work and responsibilities, resolves disputes, and assures that all members participate and understand.
2) The spokesperson (presenter); he/she actively participates and presents reports and discussion result to the class.
3) The recorder; he/she actively participates, keeps a record of the assignment and what the team has done, and prepares a report in consultation with the others.
4) The strategy analyst (reflector); he/she actively participates, identifies strategies and methods for problem solving, observes and comments on group dynamics and behavior with respect of the learning process.

Moreover Hanson (2006) explains that in a POGIL classroom, a teacher is not an expert that solely provides knowledge, but rather as a guide for students in the process of learning, developing skills, and their own understanding. Furthermore, the teacher role in POGIL classroom is as a facilitator who moves around the room observing every student group work. As a facilitator, teacher should observe and determine whether the problem is likely to be solved without intervention (Straumanis, 2010).

C. Competences of Curriculum 2013

1. Religiosity

Religiosity is a condition within a person who perceives and acknowledges the highest strength that covers human life. He/she will obey the whole religious orders and keep away from religious restrictions. It will make him/her to do better (Bintari, Dantes, & Sulastri, 2015). Religiosity does not only occur when a person is performing ritual, but also comes from internal strength. Besides, not only the activities that can be seen, but also the activities that can't be seen and occur in person's heart (Ancok & Suroso, 2011).

One concept of religiosity which is embraced widely by Psychology and Sociology experts is CY Glock and R. Stark concept of religiosity. This concept consist of five dimension (Ancok & Suroso, 2011).

1) Ideological dimension
   The ideological dimension gives recognition to the fact that all religions expect that the religious person should hold certain beliefs which followers are expected to adhere to.

2) Ritualistic dimension
   The ritualistic dimension involves the worship experience that is involved in community.
3) Experiential dimension
   The experiential dimension focuses on the personal faith experience, perhaps a transcendent encounter.
4) Intellectual dimension
   The intellectual dimension has to do with the expectation that the religious person will be informed and knowledgeable about the basic tenets of his faith and sacred scriptures.
5) Consequential dimension
   The consequential dimension includes religious prescriptions which determine attitudes of the adherents as a consequence of their religious belief.

The students' religiosity in mathematics learning process with POGIL is more related with ritualistic and consequential dimension such as performing ritual worship, being tolerant to other religion worship, and living together in harmony with other people faiths.

2. Attitudes

Attitude is an organization of several beliefs focused on a specific object or situation predisposing one to respond some preferential manners (Rokeach in Kulm, 1980). Reiser & Dick (1996) state that attitude as the personal feelings and beliefs results in a person's tendency to act in a particular way.

One of the major goals of education is to form the attitudes of the learners so that they will make responsible choices throughout their lives (Reiser & Dick, 1996). Kesuma, Triatna, & Permana (2012) state that attitude can be a major or a supportive component of learning (cognitive and psychomotor). Furthermore, they explain that the attitudes are acquired by someone to respond something. Attitudes can not observed directly except the actions and behaviors. The attitudes in Curriculum 2013 are defined as an expression of values which is manifested in people behavior. Some attitudes that can be developed in mathematics learning process with POGIL are confidence, curiosity, and responsibility.

3. Knowledge

Anderson & Krathwohl (2010) categorize four types of knowledge. Those are factual, conceptual, procedural, and metacognitive knowledge. Curriculum 2013 presupposes students to have those four types of knowledge.

1) Factual knowledge
   Factual knowledge contains the basic elements that should be understood by students if they are going to learn a certain discipline of knowledge or to solve any problems in it. For the most part, factual knowledge exists at a relatively low level of abstraction (Anderson & Kratwohl, 2010). The example of this knowledge is mathematics symbol like $=, <, >, \leq, \geq$.
2) Conceptual knowledge
   Conceptual knowledge includes knowledge of categories and classifications and the relationships between and among them; more complex, organized knowledge forms (Anderson & Kratwohl, 2010). The example of this knowledge is the arithmetic operations (the commutative principle, the associative principle).
3) Procedural knowledge
   It is the knowledge of how to do something. The something might range from completing fairly routine exercise to solving problems. It includes knowledge of skills, algorithms, techniques, and methods, collectively known as procedures (Anderson & Kratwohl, 2010). The example of this knowledge is in how to determine the solution of one variable linear equations or one variable linear inequality.

4) Metacognitive knowledge
Metacognitive is knowledge about cognition in general as well as awareness and knowledge about one's own cognition. By this metacognitive knowledge, students will become more aware of their own thinking as well as more knowledge about cognition in general and as they act on this awareness they will tend to learn better (Anderson & Kratwohl, 2010). The example of this knowledge is knowledge about solving the mathematics problems.

4. Skills

A skill is what a learner should be able to do. Skills arise from concepts and principles and provide a foundation for the development of other concepts and principles (Suydam & Dessart, 1980). Gibb (Suydam & Dessart, 1980) states that there are four basic mathematical skills. Those are the understanding of mathematical concepts and techniques of computation, application the understanding in computation, problem solving, and thinking creatively.

Otherwise, Robert Gagne (Reiser & Dick, 1996) classify four domains of learning outcomes. These domains of learning include knowledge, intellectual skills, motor skills, and attitudes. According to Gagne, intellectual skills are processes used by students that go above and beyond the pure memorization of information to the actual use of the information. Any physical activities that requires movement of all or part of the body is referred to as a motor skill. The examples of motor skills in mathematics learning are the student's ability to draw some geometry figure by using tools, to measure, etc. However, this paper only explains about intellectual skills.

Moreover Gagne explains that the lowest level of intellectual skill is the concept of learning. A student can be said has already understood concept if he/she is able to identify whether a particular thing or idea can be classified as an example of that concepts or not(Reiser & Dick, 1996).

A second and higher level of intellectual skill is rule using. Rules are combinations of concepts. Simply stating or writing the theorem is not an example of rule using, yet is knowledge. The rule must actually be applied and the result determined in order to say that a student is using a rule (Reiser & Dick, 1996).

The third and highest level of intellectual skills is problem solving. As in the case of rule using, when students are engaged in problem solving, they apply rules to help them solve problems. The distinction between problem solving and rule using is that in rule using, the student is asked to correctly use a given rule, whereas in problem solving, the student is given a problem to solve and must choose and correctly use the appropriate rules to solve the problem (Reiser & Dick, 1996).

D. POGIL in Mathematics Learning Process to Develop Students' Competences within Curriculum 2013

Although POGIL is known as a science learning strategy, it can be applied in mathematics learning process. The research from Nugraheni, et al (2013) tries to implement POGIL by using manipulative in mathematics learning process. The result states that the students problem solving ability taught using POGIL is better than the students problem solving ability taught using expository in circumference and area of circle material. Moreover, the other research from Sumardiyanto (2011) states that students' mathematics achievement, process skill, and students' activity pass through the minimal criteria by individually or classically in mathematics learning process by using POGIL in differential material. The research from Aditya (2012) concludes that students' mathematics achievement taught using POGIL is better than the students' problem solving ability taught using expository. In the other hand, the level of students' math anxiety taught using POGIL is lower than students math anxiety taught using expository.

Based on the explanation above, POGIL can be implemented in mathematics learning process to develop cognitive or affective domain of students. This paper will

explain how to implement POGIL in mathematics learning process to develop students' competences within Curriculum 2013 which is started from the introduction, main activity, and closing. Introduction can be started by greetings and praying in order to train religious value to the students. After that, the learning purpose is explained by the teacher to build students motivation to study the material and connect it in the daily life. The teacher also has to give prerequisite material to help student studying the related material. For example, to build the second floor apartment and the other will be built if the first floor has been built strongly. Similar with mathematics, the first concept has to be learned as a prerequisite to understand the next following concept.

In the main activity, the teacher organizes the student into some groups consist of 4-5 students. The teacher explains the role and responsibility of each student in every group. Each student in a group can choose a role as a manager, presenter, recorder, or reflector. This role will be rolling in every meeting in order to give an experience to the student to try all of the roles in a group. The purpose of working in a group is giving an experience to the student to have a responsibility and doing the best for their group. The other purpose is developing religious value of student to accept the other student in a group without considering the difference of religion and build a good relationship with another student.

Furthermore, in order to develop the knowledge and mathematics skills, the students have to do some activities which have been designed before in a student worksheet. The teacher has to design the student worksheet that contains learning cycle. The learning cycle consist of three important phases. Those are exploration, invention, and application. Exploration phase in student worksheet can be represented by a few of information about the materials. This information can build a curiosity of students. Then, the teacher gives a classical guide to all of the groups to identify the information that represented in the student worksheet.

In the invention phase, critical thinking questions are given to the students. Those questions guide the students to discover some facts, concepts, principles, and mathematics procedures. By critical thinking question, the student can develop their curiosity to the material and the mathematics skill that will be learned. There are three kinds of critical thinking question which can be used. Those are directed, convergent, and divergent questions. Directed questions point the student to obviously discover about the information. Convergent questions require students to synthesize relationships from their new discoveries (and previous knowledge) and lead to the development of new concepts or deeper conceptual understanding. Divergent questions are open ended and do not have unique answers (Hanson, 2006). The role of the teacher is giving classical guide to all of the groups to answer the critical thinking questions in student worksheet. Then, the students actively discuss the answer with their group.

In the application phase, the students will do some exercises to apply what they have discovered and new contextual problems. The students have to discuss to solve the exercises and the teacher monitors and helps the student if they have some difficulties in their group. In this activity, students can develop their knowledge, mathematics skills, confidence, and curiosity. The next step, the teacher gets the students to present the discussion result. In this activity teacher chooses some presenters to present the answer of their group in a class. The purpose of this activity is building students' confidence and responsibility to do their task.

Before entering the closing activity, the teacher can give a quiz to the student to do individually in order to give a feedback about how far they can understand the material which has been learned. The student will be trained to believe in their own ability and are not influenced by the others.

In the closing activity, the teacher asks the students to conclude the material which have been learned in that day and also make a reflection to the learning process. Reflection is made by giving some evaluation to every single student or to the group performance.

Besides that, the teacher also asks a question to the reflector about the learning purpose, whether it has been reached or not. Then, the teacher asks to all of the recorders from all of the groups to collect the discussion result of their group. This activity will help the student to have a responsibility as their role in that group. The teacher also gives homework to the students and tells the next materials that will be studied in the next meeting. This activity can make the student more understand about the material. The teacher closes the learning activity in that day with praying and greeting to build and develop students religious value.

CONCLUSION AND SUGGESTION

POGIL is recommended to be implemented in mathematics classroom since it can be used to develop students' competences within Curriculum 2013 based on theories and the result of relevant research. The teacher has to design student worksheet which contains learning cycle to implement POGIL in mathematics classroom. The learning cycle consists of three important phases. They are exploration, invention, and application. Exploration phase in student worksheet can be represented by some information about the materials. In the invention phase, critical thinking questions are given to the students. This questions guide the students to discover some facts, concepts, principles, and mathematics procedures. In the application phase, the students do some exercises to apply what they have been discovered and new contextual problems. Although the teacher has to work hard in teaching mathematics, the mathematics learning which is suitable with Curriculum 2013 can be implemented well.

As a recommendation to the teachers, POGIL can be implemented not only in mathematics learning in order to develop the other attitude variables, but also in another subjects such as in language classes in order to develop students' competences within Curriculum 2013 or another variables.

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