

# What has Happened in Mathematics Classroom: A Case Study in Primary Schools with High International Benchmark on TIMSS in Indonesia

Naafi Awwalunita  
Yogyakarta State University  
Yogyakarta, Indonesia  
naafi.awwalunita2016@student.uny.ac.id

Fasiha Fatmawati  
Yogyakarta State University  
Yogyakarta, Indonesia

**Abstract**—This paper describes the results of a case study aimed at determining mathematics teaching and learning processes conducted in the primary schools with high international benchmark on TIMSS. The study explores the classroom activities and also investigates the role of the teachers. Case study method was used in this study. Open-ended interviews were used. The responses from the subjects were recorded, and notes were also taken. The data were first transcribed and double-checked for grammatical errors. The major finding of the study was that cooperative learning, problem/project-based learning and positive reinforcement were generally applied. All teachers mentioned about how they used cooperative or problem/project-based learning in their mathematics classes. All of the teachers also mentioned about giving their students positive reinforcement during mathematics class. The significance of this study to teaching and learning mathematics is to find out how to apply the method to teach mathematics in primary schools despite all of the challenges. It becomes the most important step to get a successful mathematics teaching and learning in primary school. Therefore, it is important that teachers should find the best way to choose a proper method for their own mathematics classroom.

**Keywords**—*cooperative learning, problem/project-based learning, positive reinforcement, effective teaching, mathematics, primary schools.*

## I. INTRODUCTION

Learning evaluation can also be defined as learning evaluation from students achievements. On the other side, learning evaluation is evaluation from instructor/educator's effectivity. Evaluation is one of the important steps from learning process. It will show whether the learning goals are achieved or not.

Evaluation also becomes the key component that will help the student learn as in [1,2,3]. When the students know how they are doing in the classroom, they will know how they will understand the problems. It also helps the students to motivate themselves. If the students realize that they're not doing well, they will work it out to become even better as in [[4, 5]. Evaluation gives impact to a lot of education aspects such as students learning and curriculum development.

The evaluation study reveals the success of one dimension, on how much student achieve in a specific area as in [6]. This indicates whether the content /material has been carried out well. The evaluation of the curriculum does not respond to concerns as to

whether the curricular subjects is the right choice to begin with, if relevant, whether it meets the needs of students or society, whether the experts and the public are satisfied with it, whether it meets the philosophy and objectives of the school, or whether such content has been chosen wisely. Hence, evaluation should be done in addition to the assessment of student achievement.

United States of America and some Asian countries such as China, Japan and Korea are carrying out national examination as one of the benchmarks of the quality of education in their respective countries as in [7], [8], [9], and [10]. In addition to the national exam, there is international-scale assessment undertaken by at least over 40 countries in the world, which is the TIMSS. The TIMSS is aimed at assessing students' performance in mathematics and science (see Table I). For the first time after being held since 1991, Indonesia participated in the TIMSS assessment in 2015 as in [11].

TABLE I. INTERNATIONAL BENCHMARK BY TIMSS

Score	Scale
≤ 625	Advanced International Benchmark
≤ 550	High International Benchmark
≤ 475	Intermediate International Benchmark
≤ 400	Low International Benchmark

Indonesia got the score of 397 and ranked in number 45 out of 50 in mathematics rank and 45 out of 48 in sciences rank. There are a lot of studies at schools that get high/advanced TIMSS score to reveal or describe how to get that achievement as in [12, 13, 14]. However, in Indonesia, many studies used the low achievement in TIMSS as their background of the studies as in [15, 16, 17]. That somehow indicates that all of primary schools in Indonesia have not yet been successful. On the other side, Duke Province – one of provinces in Indonesia which participated on TIMSS – showed high international benchmark in 2015 (see Table II).

TABLE II. TIMSS SCORE OF DUKE PROVINCE

Primary School	Numeracy Score	Mathematics
Akasiana	557	524
Bahari	533	505
Cemara	513	499

From the table above we can see that the achievement of mathematics from those primary schools are relatively good. Those primary schools are known by researchers through

interviews and observations of the documents that they are not even on the list of top 20 schools in Duke Province on national exam score. However, those primary schools got higher TIMSS score than the average TIMSS score in Indonesia which makes this study interesting.

This paper describes the results of a case study that aimed at determining mathematics teaching and learning processes in those primary schools with the high international benchmark on TIMSS. The study explored the classroom activities and also investigated the role of the teachers.

The rest of this paper is organized as follow: Section II describes proposed research method. Section III presents the obtained results and following by discussion in section IV. Finally, Section V concludes this work.

## II. PROPOSED METHOD

This research is a case study. The data were collected using in-depth interviews with teachers about how they manage math learning in their classroom. The three teachers who participated in TIMSS assessment in Duke Province are Ms. Ana from Akasiana Primary School, Mr. Ben from Bahari Primary School and Ms. Cita from Cemara Primary School.

## III. RESULTS

The implementation of the learning process according to PERMENDIKBUD (The Ministry of Education and Culture Rules of Indonesia) number 22 Year 2016 about the standard process in primary and secondary education, consists of opening activities, main activities and closing activities. Opening activities consist of the delivery of perception and learning objectives. Main activity uses a model of learning, learning methods, classroom management, learning media and learning resources that fit the characteristics of the students and subject. While in the end of the activities, the teacher and students conclude what have they learned that day [18].

There are some similarities in the method that had been used in teaching mathematics from the three teachers interviewed. They often use cooperative learning, problem / project-based learning, and positive reinforcement in their classes. The following table shows the results of each teacher's interview related to the mathematics teaching and learning in each class (see Table III).

## IV. DISCUSSION

### A. Cooperative Learning

Student learning goals can be compiled through cooperative, competitive, or individualistic learning. In each class, learning activities are aimed at achieving the goals derived from core competencies and basic competencies. The structure of learning objectives determines how students interact with each other and teachers during instructional sessions. Each target structure has its place [19]. In those classes, all students learn how to work with others, compete for fun and enjoy fun, and work independently on their own. The teacher determines which target structure will be applied in each lesson. The most

important goal structure, and which should be used most of the time in learning situations, is cooperation.

TABLE III. MATHEMATICS TEACHING AND LEARNING

	<b>Ms. Ana</b>	<b>Mr. Ben</b>	<b>Ms. Cita</b>
<b>Preliminary learning activities</b>	Always starts with reading activity for 10-15 minutes; always uses verbal pretest or Q&A with students; written pre-test held once per week.	Always starts with reading activity for 10-15 minutes; rarely uses pretest.	Always starts with reading activity for 10-15 minutes and then followed by discussion on student's homework.
<b>Teaching Methods</b>	Cooperative learning, inquiry-based learning, problem-based learning, peer tutoring.	Cooperative learning, problem-based learning.	Problem-based learning, peer tutoring.
<b>Teaching Tools</b>	Often uses mathematics tools; sometimes uses LCD if it is needed; sometimes asks students to bring some home materials to learn mathematics.	Often uses mathematics tools; sometimes uses LCD if it is needed.	Rarely uses mathematics tools; sometimes use LCD if it is needed; sometimes asks students to bring some home materials to learn mathematics.
<b>Class Management</b>	Involves students to manage the seats and rules.	Manages the class by himself in variation so that students can work in groups.	Manages the class by himself in variation so that students can work in groups.
<b>Assignments</b>	Project-based assignment.	Problem-based assignment that has to be done in groups or individually.	Problem-based assignment that has to be done in groups or individually.
<b>Evaluation</b>	Uses student's self -journal; uses attitude journal by observing students in the classroom; daily exam; mid-term exam; final exam; final term exam.	Homework; uses attitude journal by observing students in the classroom; daily exam; mid-term exam; final term exam.	Homework; uses attitude journal by observing students in the classroom; daily exam; mid-term exam; final term exam.

Cooperation works to achieve common goals. In a cooperative situation, individuals seek out beneficial results for themselves and benefit all other members of the group. Cooperative learning is the use of small group instruction so that students work together to maximize their own learning and each. It can be contrasted with competition (students work together to achieve academic goals such as "A" grades that can only be achieved by one or more students) and individualists (self-employed students to achieve learning objectives unrelated to other students' strategies). In cooperative and individualistic learning, teachers evaluate

students' efforts based on temporary referenced criteria in competitive learning of teacher classroom students by norm. Although there are limitations on when and where teachers can use competitive and self-directed learning appropriately, teachers can arrange any learning task in the subject field with any curriculum cooperatively.

Cooperative learning provides an opportunity for students to help each other in achieving academic goals. These academic goals include developing self-confidence, improving learning achievement, improving the positive spirit in relationships among friends in groups as in [20, 21]. Cooperative learning will lead students into active students who will unconsciously improve their communication skills, take responsibility, and work together.

### *B. Problem/Project-based Learning*

Teachers can create real-world problem-solving situations by designing questions and tasks that fit into two different inquiry-based teaching frameworks: Problem-based learning deals with issues that does not necessarily result in a project, project involving complex tasks, and some forms of student presentation. This Inquiry Based Learning method involves students in creating, questioning, and revising knowledge, while developing their skills in critical thinking, collaboration, communication, reasoning, synthesis, and resilience [22]. Although this inquiry-based teaching method is slightly different from Pj-BL, but if the teacher is able to apply in the project continuously it can be referred to as project-based learning or PBL.

In line with the observations made by reference [22] and based on several studies and articles above, Pj-BL is a real problem-based learning model involving students' responsibility in learning that produces a work. Pj-BL is proven to improve long-term memory, academic achievement, enthusiasm in learning, problem-solving skills, and collaboration.

Many studies have proven that when implemented properly, project-based learning (Pj-BL) can improve content retention and improve students' enthusiasm toward learning. The Pj-BL study conducted by Asbjornsen has proven in observations conducted at High Tech and Riverpoint Academy. Project-based learning hails from a tradition of pedagogy which asserts that students learn best by experiencing and solving real-world problems as in [22]. Project-based learning comes from a pedagogical tradition that asserts that students learn best by experiencing and solving real-world problems. Project-based learning basically involves the following: students learn knowledge to tackle realistic problems as they later face the real world, improve students' ability to control their learning habits, teachers act as trainers and facilitators, students (usually, but not always) work in pairs or in groups as in [22].

Teachers in those three schools have been creating real-world problem-solving situations by designing questions and tasks. For example, Mr. Ben often asks his students to go to the market and gives them chance to interview the sellers about how they manage their selling. Ms. Ana also often gives her students some projects that can be applied on daily basis to be done in a report. A study comparing learning outcomes from students taught using project-based

learning with traditional teaching suggests that when properly implemented, Pj-BL improves long-term content retention, helping students perform as well or better than traditional students in high difficulty tests, improving problem-solving and collaboration skills, and enhancing students' enthusiasm for learning [23, 24]. Pj-BL can also provide an effective model for school-wide reform [25, 26]. Review of the 20176 MDRC / Lucas Education research literature found that the most common design principles used in Pj-BL are in line with the goal of preparing students for meaningful learning, Higher-Order Thinking, and intra / interpersonal skills [27].

### *C. Positive Reinforcement*

Skinner views reward or reinforcement as the most important element in the learning process. We tend to learn a response if it is followed by reinforcement. Skinner prefers the term reinforcement rather than reward, this is because rewards are interpreted as subjective behaviors associated with pleasure, whereas reinforcement is a neutral term. Ormrod in [28] suggests that a reinforcer is any consequence that increases the frequency of a particular behavior, whether people find that the consequence is pleasant or not. The act of following a particular response with a reinforcer is called reinforcement. Reinforcement is all the consequences that strengthen or increase the frequency of behavior [29]. For example, when the teacher tells one of the students that the teacher is really proud of the story he wrote, the students will work hard and write a better story for the next time. The positive comments that teachers provide strengthen the writing behavior of students.

The reward is determined by its effects, which does not depend on mental processes such as the conscious mind, will, or target so that it cannot be determined at the beginning [30]. Positive reinforcement is a stimulus to a situation that can increase the likelihood of a future response in the same situation [30]. According to Ormrod [28] in general positive reinforcement forms include:

a) Concrete reinforcers - actual objects that can be viewed and touched directly e.g. snacks, stickers, and toys. According to Ormrod in [28] this reinforcement is effectively applied to children.

b) Social reinforcer - a gesture or mark given to a particular behaviour. Examples of Social reinforcers are smile, attention, applause, hugs, praise, and thanks.

c) Activity reinforcer - giving a preferred opportunity or activity to someone to reinforce the less favoured activity. Activity reinforcer is usually called the Premack principle. The example of Activity reinforcer is when a child will want to sit quietly and do the problem immediately to get home early from school.

d) Positive Feedback - sometimes the right answer or task that has been done well enough to improve the deed in the future.

As an example of positive reinforcement is that three of the teachers often give a star sticker, applause, and thumbs up for students who manage to answer questions. Ms. Ana always gives stars to the student with specific achievement for example, being active, responsible, honest, and good leader and she also gives some students year-end gifts.

Meanwhile, Mr. Ben always gives applause and praises the students that give his/her opinion confidently. He also often gives gifts to the group with specific achievement such as best group, the most confident group, the neatest group, etc. The same reinforcement is also given by Ms. Cita in her class. She always praises her students with kind words.

In addition to positive reinforcement there is also a strengthening that can lower even eliminate a habit called negative reinforcement. Strengthening is proven to improve student's positive behaviour. Hence, by using positive rewards, educators are directed to appreciate each of their students. This is supported by the establishment of a competitive learning environment and it is conducive to the three teachers. By using positive rewards, students' positive attitudes toward learning are also increased so that learning takes place pleasantly.

The key to successful learning lies with the teacher. The student-centered learning process will have a good impact not only on cognitive development but also affective and psychomotor aspects as in [31, 32, 33]. Cooperative learning not only leads students into active students who will unconsciously hone their communication skills, take responsibility, work together but also improve academic motivation and achievement. Problem / project-based learning that involves students' responsibility in learning that produces a work. Pj-BL is proven to improve long-term memory, academic achievement, enthusiasm in learning, problem-solving skills, and collaboration. The provision of positive rewards affects the positive attitude of students in learning process so that the learning process can be fun.

#### V. CONCLUSION AND RECOMMENDATION

This paper has described the results of a case study aimed at determining mathematics teaching and learning processes conducted in the primary schools with high international benchmark on TIMSS. This paper has also explored the classroom activities and also investigates the role of the teachers. The significance of this paper to teaching and learning is to find out on how to apply the method to teach mathematics in primary schools despite all of the challenges.

Further research is needed on the learning process that occurs within these classes. The drawback of this research is that researchers only use in-depth interview techniques with the three teachers in each elementary school. Very likely there are other factors that affect the success of learning in these classes.

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