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COMPARISON OF NEW MATHEMATICS TEACHING METHODS WITH TRADITIONAL METHOD

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Abstract

The aim of this paper is to compare the mathematics teaching methods, and study their consequences on mathematics learning. Numerous studies have shown that students experience mathematics anxiety which is a feeling of tension and fear that interfere with math learning. This may be attributed to the applied teaching methods in the classrooms. The three major teaching methods are: traditional, problem-solving, and discovery learning. Traditional teaching method is a teacher-centered instruction, while problem-solving method is a as teacher and student-centered which is based upon how teacher uses the four steps of problem-solving methods in teaching Mathematics. In discovery learning method, teacher plays the role of facilitator through involving students in varied activities associated with the discovery and construction of the

knowledge. The qualitative case study method was considered more feasible and appropriate to meet the aim of this study. Data were collected using observation and semi-structured interviews with teachers in the secondary schools in Malaysia. It was observed that traditional, problem solving and discovery learning methods were practiced by the teachers. The findings reveal that students are more successful when systematic problem solving method based on Polya's approach is incorporated into discovery learning. Consequently, there should be more emphasis on teaching methods which include less lecture, more student-centered classes and more discussion. The findings suggest that problem solving and discovery methods not only contribute to better mathematics learning but also enhance students' creativity to cope with life challenges.

Keywords

Teaching Methods, Discovery Learning, Problem Solving, Traditional Methods

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1. Introduction

Mathematics became the driving force for almost all technological and scientific developments in the nineteenth and twentieth century. It has big influence on our professional and social daily life activities (Maasz and Schloeglmann, 2006). It has crucial role for students' success and breeding a developed nation. Mathematics education has always been treated as an important section of general education and specifically science education. It is believed that a teaching method is essential to any meaningful development effort.

These variations of beliefs and values concerning mathematics learning result in different mathematics educational systems. The role of teachers is to facilitate students' thinking and learning, therefore, teacher should attempt to motivate students to learn. To be aware of teaching practice activities done by teachers, we should have enough knowledge about learning and teaching methods. Different teaching methods such as traditional, problem-solving, and discovery learning have been used in educational systems all over the world. The application of these teaching methods is explained more in the next sections. Finally, we present the optimum teaching method for mathematical subjects.

2. Literature Review

2.1 Teaching Methods

Learning is one of the significant features of current psychology. Different learning theories and teaching methods have been used in educational system all over the world. These three teaching methods such as traditional, problem solving, and discovery learning are based on the different learning theories such as behaviorism, cognitivisim and constructivism. Teaching methods involves the use of learning theories and each theory has different outcomes in mathematics education.

In order to succeed in teaching mathematics, teachers should be aware of different teaching methods so, they can employ this knowledge as a basis of their mathematics education strategies. The teachers agreed that mathematics teaching and learning is an ongoing process through which students must develop a solid understanding of appropriate mathematics concepts and procedures in each academic level. Teachers ought to give students enough confidence to discover their mathematics problems and think critically to solve them as well as their life problems.

Next sections discuss three teaching methods namely traditional (teacher-centered), problem solving (teacher and student-centered), discovery learning (student-center).

2.2 Traditional Method

Traditional method is based on the behaviorism learning theory. Behaviorist refers to the learning theories emphasizing on changing behavior which results from learners' associations of stimulus-response. It asserts that learning is a change in behavior due to experience (Ormord, 1995).

In a mathematics class using traditional method, the teacher reviews previous material and homework, and then demonstrates low-level problem solving followed by seatwork imitating the teacher's demonstration (Stonewater, 2005). This pedagogical approach of placing the primary focus on the teacher as a transmitter of knowledge (that is, teaching by telling) is representative of behaviorist theory (Hackman, 2004). The common method of teaching mathematics using traditional method is a teacher-centered and giving lecture is the dominant situation.

2.3 Problem Solving

Problem solving is a significant element of mathematics education. This method is based on the cognitivisim learning theory. In fact, problem solving in mathematics help students to develop a wide range of complex mathematics structures and gain the capability of solving variety of real life problems (Tarmizi & Bayat, 2012). Moreover, National Council of Teachers of Mathematics (NCTM 1980) has emphasized that the mathematics teachers should focus on problem solving throughout their teachings since it "encompasses skills and functions which are an important part of everyday life". Furthermore, problem solving helps people to adapt to changes and unexpected problems in their careers and other aspects of their lives. Problem-solving lies beyond mathematics teaching dimensions so that students experience the influence of mathematics in the world around them (Taplin, 2011).

Concerning these required skills and approaches to the problem solving, (Polya, 1945) stated four-step approach to problem solving including:

i. Understand the problem: it is impossible to solve a problem, if you do not know what the problem is. What is known or unknown? Is there enough information or is more information needed? What do the terms mean?
ii. Devise a plan: the way we solve the problem. Possible strategies: (a) Draw pictures (b) Use a variable and choose helpful names for variables or unknowns. (c) Be systematic. (d)Solve a simpler version of the problem. (e) Guess and check. Trial and error. Guess and test. (Guessing is OK.) (f) Look for a pattern or patterns. (g) Make a list
iii. Carry out the plan: If the plan does not seem to be working, then start over and try another way. Often the first approach does not work. Do not worry just because an approach does not work. It does not mean you did it wrong. You actually accomplished something, knowing a way does not work is part of the process of elimination.
iv. Look back: Did you answer the question? Is your result reasonable? Is there another way of doing the problem which may be easier?

In current mathematic science, problem solving is not only help to gain more skill and knowledge to solve the problem, but also it goes further and help to increase reasoning skills among students (Hmelo et al., 1998). Therefore, problem solving methods is considered as an essential factor to increase the level of achievement in mathematic students. It can be also utilized to solve problems from the real life.

2.4 Discovery Learning

This method is based on the constructivist approach which is a learner-centered approach that emphasizes the importance of individuals actively construct their knowledge and understanding by the guidance from the teacher. In this method, teachers should not attempt to simply pour information into children's minds. Rather, children ought to be given confidence to discover their world, find out knowledge, consider, and think critically with vigilant supervision and significant guidance of the teacher (Eby, Herrel & Jordan, 2005). The constructivist approach was proposed by William James' and John Dewey's philosophies of education and come from many other persons such as Jean Piaget, Maria Montessori and Lev Vygotskty and from educational movements such as progressive education, inquiry or discovery learning, open education and whole language teaching (Gagnon & Collay, 2001).

In discovery learning method, teachers should not attempt to simply pour information into children's minds. Rather, children ought to be given confidence to discover their world, find out knowledge, consider, and think critically with vigilant supervision and significant guidance of the teacher (Eby, Herrel & Jordan, 2005).

This method emphasizes that students should form their own interpretation of evidence and submits it for review. Within mathematics education, students have to build their own understanding of every concept of mathematics, so that the main responsibility of teaching is not explaining, lecturing, or attempting to convey mathematical knowledge, but creating situations for students to promote their mental structures.

In discovery method, students are not passive recipients of knowledge but they create (construct) new mathematical knowledge by reflecting on their physical and mental actions. Therefore, learning reflects a social process in which children engage in dialogue and discussion with themselves as well as others as they develop intellectually (Hanley, 1994). This method is the best method to move away from traditional method or teacher-center practices, and more empowers teacher and students both for better critical thinking and creating changes in old teaching methods (Sawada, et al., 2002). Mathematics teachers following a discovery learning method may favor extending class time to engage in varied activities associated with the discovery and construction of knowledge. Hence, students will participate in knowledge construction and real world problem solving rather than focusing on mathematical abstractions.

Discovery learning points to learning that occurs once students are enquired to find out something by themselves. For example, rather than telling students the value, the teacher asks them to measure spherical objects to find out the value themselves (Cruickshank, Bainer, & Metcalf, 1995). Teachers use discovery learning to achieve three educational goals. Firstly, they would like learners to recognize how to find out things and think on their own. In fact, they would like them to be less dependent on getting knowledge from teachers and acknowledge the conclusion of others. Secondly, discovery learning users would like learners to see in what way knowledge is achieved. It indicates that teachers would like students to be enabled to learn by gathering, organizing, and analyzing information to achieve their own conclusion. Thirdly, the teachers would like learners to employ their top thinking skill. Among other things, they want students to analyze, synthesize, and evaluate (Cruickshank et al., 1995).

One of the characteristics of discovery learning is that the role of the teacher is not imparting knowledge but rather creating and guiding classroom experiences in which learners engage in order for discovering knowledge. Second characteristic of discovery learning is that while learners deal with discovery, the teacher motivates them to think profoundly. And the third feature is that learners acknowledge the challenge of realizing something by themselves rather than requiring the teacher gives them a reply (Cruickshank et al., 1995).

3. Methodology

The qualitative case study method was considered more feasible and appropriate to meet the study aim. Data were collected using observation and semi-structured interviews with seven teachers, who were selected by the snowball method, in two secondary schools at different states of Malaysia. However, in this paper, we only bring the data related to the three teachers including Teacher A, Teacher B and C to examine different teaching methods. The questions asked in the interviews and the criteria considered in the observations were related to three the teaching methods. The participants (the teachers) were interviewed and their performances in their classes were observed to analyze their teaching methods.

4. Findings

As teachers have an important role in presenting the content of text books to students, the researchers conducted some interviews with the mathematics teachers and observed their classes during their teaching hours.

Our observations and interviews results showed that teaching methods including traditional (teacher center), problem solving (teacher and student center) and discovery learning (student center) were practiced by the teachers. As examples for considering mathematics method of teaching by the teachers, based on different methods of teaching, we selected three of them teachers A, B, and C.

4.1 Teacher A

The observation supported that Teacher A used two kind of teaching methods including traditional and problem solving. The observations confirmed that she paid attention to the students' ideas regarding the course and provided opportunities for them to think about mathematics problems and subjects and allowed them to participate in the class activities and group discussions. She used the blackboard and extra mathematics books in the class. Although the class was managed by more teacher-centered techniques, the students participated in the class through discussions on their understanding and reasoning.

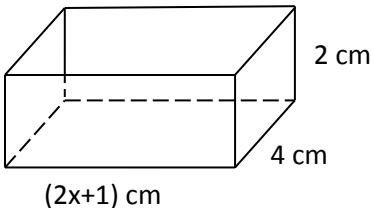
In interview when asked about methods of teaching in the class, she replied:

> *"When I teach a topic, firstly I give examples and I solve them on board, then I give some other questions to my students and ask them to solve them, when they are solving the examples, I go around the class, and I can see whether they understood the topic. Sometimes I just ask a student who is in middle level to answer the question if they answer my questions, I know the other students understood it as well". (Interview with teacher A, August 2011, p.8).*

In her classes, she allowed her students to ask questions and discuss about the topic of the mathematic and she gave her students extra tasks and exercises especially when they were weak in certain areas to enhance her students' understanding. She believes that students should take part in teaching and using all their senses to optimize their understanding and learning deeply.

Also the observations were conducted when teacher A was teaching liner equations and solving some mathematics problems. Observation showed that she was teaching liner equation topic from Form 2 for middle level students. The observations confirmed that she started the class based on her lesson plan and the main textbook. The example of linear equation was to find

the value of x given the volume of the cuboid is 88cm^3. She used four steps of problem solving and discovery learning to solve the problem.



Teacher A posed a mixed problem with two aims: geometry and algebra and asked students to find the x with volume 88 cm^3 to show how to solve a linear equation:

$v = 88cm^3$

$(2x + 1) \times 2 \times 4 = 88 \rightarrow (2x + 1) \times 8 = 88 \rightarrow 2x + 1 = 11 \rightarrow 2x = 10 \rightarrow x = 5$

The observations showed that she used mixed methods of teaching and she was very flexible in her teaching methods and used problem solving and discovery learning activities, although the time was limited (around 65 minutes in one session).

4.2 Teacher B

The observation was conducted when she was teaching geometry. In her class, students were working together and she helped them while they were solving the problems. She also collected students' notebooks which they used for doing their homework. In another session when the researcher observed her class, she was teaching liner equation, all of her students took part in the class and problem solving activities.

(1) $\frac{3}{4}\mathrm{X} - 3 = \mathrm{X} + 4$ (2) $\frac{8\mathrm{m} + 7}{4\mathrm{m} - 3} = 3$ (3) $\frac{\mathrm{Y} - 6}{3} = \frac{6 - \mathrm{Y}}{2}$

She had two purposes in presenting these exercises including teaching fraction and equations. In this way, she used the problem solving method to solve the problem by engaging the students in the problem solving process.

She gave an introduction about a new subject before starting it, but she did not review the previous lessons to relate the new lesson to the previous one. Therefore, the students may have some difficulties in linking the previous lesson the new one. For example, she gave the students 3 exercises regarding linear equation as following:

$$(1)\ \frac{3}{4}x - 3 = x + 4 \rightarrow \frac{3}{4}x = x + 3 + 4 \rightarrow \frac{3}{4}x = x + 7 \rightarrow 3x = 4(x + 7)$$

$$\rightarrow 3x = 4x + 28 \rightarrow 3x - 4x = 28 \rightarrow x = -28$$

$$(2)\ \frac{8m + 7}{4m - 3} = 3 \rightarrow 8m + 7 = 3(4m - 3) \rightarrow 8m + 7 = 12m - 9$$

$$\rightarrow 8m - 12m = -9 - 7 \rightarrow -4m = -16 \rightarrow m = 4$$

$$(3)\ \frac{y - 6}{3} = \frac{6 - y}{2} \rightarrow 2(y - 6) = 3(6 - y) \rightarrow 2y - 12 = 18 - 3y$$

$$\rightarrow 2y + 3y = 18 + 12 \rightarrow 5y = 30 \rightarrow y = \frac{30}{5} \rightarrow y = 6$$

While the students were doing the exam, the teacher discussed with them and asked them what are the differences between y-6 and 6-y and what happens in this exam if the equation be: $\frac{Y-6}{3} = \frac{Y-6}{2}$. This discussion among them was interesting for students.

She teaches low and middle level students in her classes. She had a schedule for her teaching instruction and tries to follow a student-centered method of teaching. In fact it was not possible because there were aroud40 student in her class, also she using problem solving method of teaching. However it depends on the topic and the situation of the class.

In interview, she mentions that she uses diverse examples to describe the mathematics subjects in her classes. Sometimes, she wants her students to ask questions and discuss about them and also allows them to share their ideas in the class. Regarding extra activities, she explains:

"Normally I give them homework to do at home and hand it in the next session; I also give them some exercises in the class to check whether they understand the topic" (September 2011, p. 40).

Also she explains her approach in dealing with the students' differences as follows:

> *"We should know our students by name and respect them in the class and we also need to give them questions based on their comprehension level, we should give easier questions to weak students". (Interview with Teacher B, September 2011, p. 39).*

She believes that students have a very important role in their learning process. She provided students with the opportunities to participate in the class activities and group discussions.

4.3 Teacher C

In the observation, Teacher C tends to used method of discovery learning although sometimes using traditional method for beginning the new lesson. In good spirits, she began to review the previous lesson and gave an introduction about the new subject before starting it. She had a lesson plan for teaching and paid attention to the students' ideas regarding the course. She allowed the students to participate in class activities, provided opportunities for them to think about mathematic subjects, and allowed group discussions in the class. She also used whiteboard, power-point, educational CDs, and extra mathematical books in the class. While doing exercises, she paid attention to students' ideas to clarify and allowed to students to find the problems.

In interview with her idea about methods of teaching, she believes that in solving mathematics problems using discovery learning to improve creativity of the students. She encouraged students using skills of problem solving approaches for solving mathematics problems.

> *"We have many activities for students. In class, we do so many exercises and problem solving. We also have outdoor activities; in this school we take students for math, science and career festivals. These festivals encourage students to improve themselves in mathematics and science. Students should improve themselves to know what concepts in mathematics are related to other concepts in physics and so on". (Interview with teacher C, October 2011, p. 71)*

An example that she wrote on the whiteboard was linear equation with two variables $\frac{x}{y} = \frac{7}{2}$ and $x + y = 63$, with answers $x = 7$ and $y = 2$. And with the result $x + 7 = 9$ which was an interesting problem for discussion. Teacher C asked the students to solve the posed problem as $\frac{x}{y} = \frac{7}{2}$ and $x + y = 63$.

If $\frac{x}{y} = \frac{7}{2}$ and we know that $(7, 2) = 1$, so we can say $x = 7$ and $y = 2$ which was the students answer in the mathematics class room, then $x + y = 9$. But in this case there is another function$x + y = 63$, so we cannot say $x = 7$ and $y = 2$ because $x + 7$ doses not 63, so we have to solve the problem as two equations with two unknowns because we want to find the solution of the equation by following:

$(1)\ \frac{x}{y} = \frac{7}{2} \rightarrow 2x = 7y \rightarrow 2x - 7y = 0$ and $(2)\ x + y = 63$

$\rightarrow y = 63 - x \rightarrow 2x - 7(63 - x) = 0 \rightarrow 2x - 441 + 7x = 0$

$\rightarrow 9x = 441 \rightarrow x = \frac{441}{9} = 49 \rightarrow y = 63 - 49 \rightarrow y = 14$

Then the real answer is $x = 49$ and $y = 14 \rightarrow x + y = 63$

She applied the method of discovery learning. The observations confirmed that she encouraged the students to express their ideas about the concept. She asked questions which were relevant to the students' level of learning and allowed them to ask questions and discuss about the subject. Hence, she managed the class by student-centered method. Students were active during the teaching and learning activities, and the teacher had planned the activities.

5. Discussion

This section aims to discuss the findings of interviews and observations of the three teachers regarding teaching practices by considering teaching methods. Teaching practices have been analyzed from the answers of the participants' interview as well as the observations done by the researchers.

According to these interviews and observations and based on the authors' experiences in teaching mathematics, teachers usually tend to use problem solving and discovery learning methods in their teaching method. It should be noted that it is not possible to exactly declare that the teachers use one method at all times. They may apply other methods such as traditional method if it is necessary. However, due to the limited teaching time and large number of students in a class, teachers are more likely to apply problem solving method.

Teacher A tends to use mixed methods of traditional (theory of behaviorism) and problem solving, teacher B tends to use problem solving, and teacher C tends to use discovery

learning. Based on the observations in the classes and experiences of authors during many years teaching mathematics, students in the traditional teaching classes have difficulties to understand the subjects of mathematics and they have anxiety when it comes to exams and class activities and discussions. However, in the classes that teacher uses other methods, students are involved in class activities, group discussion with each other and with teachers, and they have less or no anxiety to take exams.

6. Conclusion

The findings suggest that problem solving and discovery learning skills not only contribute to better mathematics learning but also enhance students' creativity to cope with life challenges. Since discovery learning gives students the opportunity to think creatively. It should be more emphasis on teaching methods which include less lecture, more student directed classes and more discussion. In classes using problem solving method student are more active, they think better, and they have less anxiety for exams. In sum, the results indicate that students who learn mathematics by problem solving and discovery learning methods are more active in comparison with the students under the traditional teacher-centered method. These approaches, mainly, encourage students to think critically in their daily life and enhance their thinking, reasoning, knowing, and applying skills .Using these methods prepare student to solve problems appropriately and encounter with challenges in their life. The findings reveal that students are more successful and encourage when systematic problem solving based on Polya's approach is incorporated into discovery learning.

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