Problem Solving Schemes of Secondary School Mathematics Teachers

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Abstract

The purpose of this study is to determine the problem solving schemes among Form Two mathematics teachers. The subjects were asked to respond to five mathematics inventories regarding their conceptions towards mathematics and problem-solving in order to get some background information before they were involved in the clinical interviews.

The majority of the subjects seemed to believe that mathematics is just a field of formal knowledge. They viewed mathematics from two different perspectives, perspectives of pure mathematics and perspectives of applied mathematics. They seemed to view mathematics as dualistic in nature. The majority of the subjects tend to believe that problem-solving was just a crucial component in school mathematics. They agreed on the importance of problem-solving in daily life and the difficulties encountered in making problem-solving the focus of teaching. However, each of them emphasized different aspects in his or her own classroom teaching. The subjects' focus of teaching relied on individual conceptions towards mathematics and conceptions toward problem-solving. The findings showed that some subjects emphasized manipulations of numbers and operations, basic concepts, and memorization of basic facts. While others focused on heuristics in problem solving which they viewed as similar to algorithmic solutions.

Although some subjects viewed mathematics from a utility viewpoint, these aspects were not given due consideration in their classroom teaching. Their main purpose of teaching mathematics in school is to help students pass their examinations. Most of the subjects use their own experiences during students' time in carrying out teaching activities in classrooms. Their conceptions towards mathematics and conceptions towards problem-solving seemed to be inconsistent with their teaching practices in the classrooms.

Introduction

Mathematics is one of the core subjects in the Integrated Secondary School Curriculum in Malaysia, and is compulsory for all students. One of its main focuses is on problem solving and teachers are urged to give due emphasis to problem solving in their planning and teaching. However, the rate of success and nature of implementation vary depending on the teachers' understanding and conceptions about problem solving. Prior to the implementation of the Integrated Secondary School Curriculum in 1989, all mathematics teachers were exposed to the National Educational Philosophy implementation plans of the mathematics syllabus and its explanation, a few new aspects such as problem-solving; teachers' role; integration in mathematics, the use of mathematics and the history of mathematics; teaching strategies and the use of text books and other resources through some orientation workshops.

Problem-Solving in Mathematics Curriculum

Mathematics teachers are advised to give specific consideration towards problem-solving whilst planning and teaching a particular subject topic, befitting its status as the main focus in KBSM mathematics (Ministry of Education, 1989). This view of the importance of problem-solving in mathematics education is parallel with the opinions forwarded by several mathematics educators (Carpenter, Corbitt, Kepler, Lindquist & Reys, 1980; Writt, 1975; Braunfeld, 1975; Lester, 1977). Begle (1979), for example, is of the opinion that the core of teaching mathematics is problem-solving. According to Begle(1979), problem-solving should be the main goal in mathematics education.

In the context of the teaching of mathematics, problem-solving which is one of the main focuses of KBSM mathematics consists of direct exposure to several heuristics suggested by Polya(1957). A heuristic concept means a method or general way of solving problems which do not have a particular strategy or algorithm. Schoenfeld's (1980) flexible heuristics, defines heuristics as a general proposal

which is free of any title, which helps a person to understand and use known sources effectively to solve a problem. The study of problem-solving may be categorized into three groups. First, the study of the relations between heuristic teachings with the ability to solve problems (Kantowski, 1977; Schoenfeld, 1979). Secondly, the study of the cognitive process that occurs when students or teachers are solving problems (Kantowski, 1977; 1982; Owens, 1987; Silver, 1979). Thirdly, the study of attitudes, perceptions, conceptions and behaviors of students and teachers while solving problems (Bush, 1986; Cooney, 1985).

In the context of teachers' behaviours, several areas of basic conceptual knowledge about the process of problem-solving have been identified (Kessler, 1985; McGalliard, 1983; Thompson, 1982). Thompson (1982) for example, found that teachers' conceptions about mathematics and the teaching of mathematics are closely related to their behavior while teaching mathematics. Nevertheless, Thompson (1982) found that the teachers' conceptions about mathematics are not congruent with what they were practicing. For example, he found in his study that a teacher believed that activity was important in the teaching of mathematics to train the skills of observation, but in practice teaching was more in the form of explaining mathematical facts.

Belief Systems
Several previous studies have focused on the teachers' behaviours while teaching in a classroom. Harvey and his coauthors (1961) stressed that teachers who have different conception systems show differing teaching styles. Baird (1973) is of the opinion that teachers' behaviour whilst teaching actually reflect educational values, beliefs and goals which they want to achieve. Furthermore, Buchanan (1987), Kesler (1985) and Thompson (1982) asserted that mathematics teachers' behaviors are influenced by their understandings, attitudes, perceptions, experiences and conceptions about mathematics. Nisbett and Ross (1980) also stressed the importance of taking into consideration teachers' belief systems in any research on teachers' thinking. Wehling and Charters (1969) analyzed some data on teachers' belief systems towards the teaching and learning processes. Eight teachers' belief dimensions towards the teaching-learning process have been identified. Two of these dimensions are related to education goals. First is the stress upon content which refers to the grasp on facts, information and skills. Secondly, the stress upon the ideology of personal compatibility referring to the importance of compatibility between teaching and the students' need. In relation to the belief system, there are a few basic questions which are still not answered satisfactorily. For example: (1) What are the mathematics teachers' conceptions about problem-solving? (2) What are the mathematics teachers conceptions about the teaching and learning of problem-solving situation? (3) How do those conceptions influence the behavior of teaching problem-solving?

Aim of Study
        This study seeks to address several questions. What are the secondary school mathematics teachers conceptions about mathematics, teaching and learning of mathematics? What is the position of problem-solving in the teaching of mathematics ? Is the solving of mathematical problems really given due emphasis in classroom teaching ?

Sample and Methods of Study
        This study involved eight Form Two mathematics teachers of five secondary schools in the northern part of Peninsula Malaysia. The method utilized in the study was qualitative. The teachers were

observed and interviewed using the clinical interview technique based on Piaget's model of clinical interview put forward in Constructivism
(Steffe, 1986). Four interview sessions were carried out for a duration of between 30 to 40 minutes each, involving a) a mental picture of mathematics and problem solving,
b) a problem solving session, c) belief system, and d) perceptions and practices.
The interview sessions involved three main procedures: observation, questioning, and evaluation. According to Ginsburg(1981), clinical interview techniques depend very much on the individual verbal reflection, how the questions were put forward and the creativity of the researcher. Video-tapes were used in interview sessions and later transcribed for data analysis. Categories were derived based on the verbal and non-verbal information obtained.

Results and Conclusions

Conceptions of Mathematics

Conceptions of mathematics involve seven different aspects, that is: mental picture, school of thought, perspectives of mathematics, origin of mathematics, attitude towards mathematics, nature of mathematics, and good mathematics class. Table 1 shows a summary of Conceptions of Mathematics.
Table 1 : Conceptions of Mathematics

ASPECT	DESCRIPTION
Mental pictures	**Contents**: Involves numbers, shape, size, space, manipulations of numbers and problem solving. **Manipulation skills**: as exercises in developing basic mathematical skills
School of thought	Mathematics involves the integration of various elements such as numbers, symbols and interrelations among those elements are shown in mathematics operations. Represents the **formal** school of thought.
Perspective of mathematics	Mathematics involves some basic operations. Knowledge of mathematics is important in daily life. Viewed mathematics from **utility** perspective.
Origin of mathematics	Mathematics is **developed** from daily life activities. From time to time mathematics is developed when it is found to be very useful.
Attitudes towards mathematics	The majority **do not like mathematics** in school because the teaching of mathematics was ineffective. Begins to love mathematics after getting wide exposure to mathematics in teaching.
Nature of mathematics	Seems to see mathematics as **dualistic** in nature, though there are some weak signs of multiplistic in nature
A good mathematics	Students play active parts in discussions and work hard to find their

class	own solutions

Conceptions of Problem-Solving

Conceptions of problem-solving involves six different aspects, that is, mathematical problems, scientific problems, source of problem, problem-solving, mathematical figures, and the focus of mathematics in the Integrated Curriculum. Table 2 shows a summary of conceptions of problem solving.

Table 2   Conceptions Of Problem-Solving

ASPECT	DESCRIPTION
Mathematical problem	A difficult word question, challenging, and is related to every day problems. Its solution requires multiple concepts and skills. Mathematics and science concepts are interrelated. Mathematics involves manipulations of numbers and symbols, whereas science involves observations and experiments
Scientific problem	Consists of problems in life. Involves quantitative data, memory and comprehension
Source of problem	Arises due to three factors: not interested, concepts are not acquired, and lack of basic skills. Positive environmental factors and peer support help in problem solving.
Problem solving	Is found to be difficult because it involves mathematical concepts in solving problems about life. Students need to understand the problem and concept involved as well as grasp certain skills. Looking back is very important in problem solving.
Mathematical figure	Polya, because basically this is the name usually related to mathematical problem-solving methods.
Focus of mathematics	Students get benefits in problem solving activities in schools. Helps in the developing productive human resources for nation building.

Two of the subjects do not practise Polya's heuristics in problem-solving due to several reasons such as students' weaknesses, limited time and that the method is not needed to answer examination questions. According to them their students were weak in the basics of mathematics and did not grasp the required skills. Examples of a subject's behavior are displayed below:

        I: How is the implementation of problem-solving in class ?

        S: I hardly use it ... it's a waste of time. In problem-solving, he has to write it down, and actually it does not attain its goal.

I: Are there any other ways?

S: Usually there are not many, if I do diversify, students will get

confused. There are two or three methods, but are not stressed upon. I   show them the simple ones, the general ones the students can do   themselves.

Teaching Activities

Subjects' views on how to handle and manage classroom activities were analyzed from six specific aspects: goals of teaching, goals of learning, teaching activities, focus of teaching, teaching assessment and model teacher. A summary of subjects' classroom teaching practices is displayed in Table 3.

Regarding the goals of teaching, the majority of the subjects agreed that their main aim is to provide students opportunities to think and reason out logically. However, two of them

explained that their aim was to help students to get through the examination. Examples of their responses are:

I :   What is your aim in teaching mathematics?

S1 : To disseminate whatever is in the syllabus, guide them in using

      mathematics, and finally help students to pass their examination.

S2:   Mathematics is my option…anyway, that was not my choice either.

      Besides that, it is for students to pass an examination.

In classroom teaching, the focus was very divergent. The majority of subjects emphasized algorithmic aspects, while others focused on examination questions and questions which were related to daily activities. Examples of subjects' responses were :

I :   What is your focus in mathematics teaching?

S1 : It has to be on understanding the concepts, otherwise it will be difficult

      for students to follow ….

S2 : My focus is on daily activities which are related to the topics …

Table 3 : Classroom Practices

ASPECT	PRACTICES
Goals of teaching	To disseminate to students the basic concepts as required in the curriculum. To give students a chance to think and analyze logically, to build a useful foundation in life and to train one to have an inquisitive mind.
Goals of learning	Based on observations, most students do not have specific goals in learning mathematics, except to pass their examination. Some teachers believe in their students' potential and expect them to acquire the necessary skills in problem solving.
Teaching activities	Most of the subjects like to teach topics which appear in the examination. Students are not given the freedom to choose their own problem-solving strategies. Some teachers pay attention to algorithmic aspects, and in teaching tend to be from applied

	mathematics perspective.
Focus of teaching	Focus on different aspects. Some teachers place importance on the understanding and acquisition of basic skills in mathematics operations, proper sequence in the thought process, and others on the amount of work that the students do.
Teaching assessment	Students' reactions such as paying attention in class, asking questions and achieving excellence are considered important to assess teaching.
The **model** teacher	No model teacher. However, an expert teacher should have three main characteristics: flexible in the problem-solving strategies to suit students' abilities, attempt to determine student's ability, and knowledgeable in problem solving techniques.

Conclusions

It seems that most teachers in this study have conceptions which can be categorized as representing a formal school of thought, that is, mathematics consists of numbers and symbols compounded through mathematical operations. They see mathematics from its utilitarian perspective, even though in actual teaching practices, this aspect is not stressed. More emphasis is given to the algorithmic aspect to ensure students' ability in answering examination questions. Mathematics is seen as dualistic in nature. Nevertheless, this view is restricted to the basic nature and teaching of mathematics only.

Regarding mathematical problem-solving, the teachers do not have specific scheme. For the majority of them, problem-solving is only an important aspect in the New Integrated Curriculum because the skill in teaching problem-solving has a direct relation to a person's ability to overcome problems in everyday life. Nevertheless, problem-solving strategies did not get their main attention in their teaching because of the examination orientation nature of the curriculum, whilst problem-solving procedures and strategies are not evaluated in the examination. They seem to be more confident in the teaching method which they themselves had experienced in their school life.

It seems that, there are discrepancies between the teaching practices of teachers in this study and their conceptions of mathematics and of problem-solving. The views displayed by the teachers also reflect that they did not receive ample exposure to the New Integrated Mathematics Curriculum and how to implement it at the school level. The information that most of them received is only based on text books and other additional information about mathematical problem-solving techniques presented through professional advancement courses which they had attended, and even these were very limited. This phenomenon resulted in teachers being unable to embrace the real aspirations of the New Curriculum as had been hoped. Although this phenomenon should not be generalized because they may be isolated cases, it is clear that such phenomena should be studied thoroughly and extensively so that we will be able to identify the real factors contributing towards or hindering the successful implementation of the New Integrated Mathematics Curriculum in Malaysia.

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