ORIENTATIONS OF SCHOOL MATHEMATICS IN MALAYSIA

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Abstrak** Kertas ini membincangkan tentang perkembangan mata pelajaran matematik di sekolah dari segi pembelajaran, pengajaran dan kurikulumnya yang merupakan komponen-komponen utama dalam pendidikan matematik. Ketiga-tiga ciri ini dibincangkan berasaskan objektif-objektif matematik seperti yang terkandung dalam huraian sukatan mata pelajaran sekolah menengah di Malaysia. Kurikulum matematik sekolah selama ini yang menekankan penghimpunan fakta dan pengetahuan tidak mampu untuk merangsang pemikiran pelajar. Ini adalah kerana sisem pendidikan kita terlalu berorientasikan peperiksaan, akibatnya para guru serta pelajar "mengajar, belajar' untuk peperiksaan dan ini tidak memadai untuk merangsang pemikiran pelajar. Adakah pelajar–pelajar sekolah yang mendapat "A" dalam matematik di peperiksaan kebangsaan merupakan pelajar-pelajar yang berkemampuan berfikir serta menyelesaikan masalah-masalah 'non-routine' dalam matematik? Satu lagi persoalan yang dibincangkan dalam kertas ini adalah mengenai istilah konsep pemahaman (understanding) pelajar-pelajar dalam matematik yang kerap digunakan dalam kalangan para pendidik. Isu yang dibincangkan adalah mengenai jenis pemahaman yang dipraktikkan atau dititikberatkan di alam persekolahan matematik masa kini iaitu "instrumental understanding' dan "relational understanding". Kertas ini tidak menawarkan sesuatu yang baru ataupun suatu formula yang ajaib untuk mengatasi masalah-masalah yang dibentangkan di atas tetapi hanya sebagai suatu pentas untuk 'perturb' pemikiran para pendidik mengenai sistem pendidikan matematik di sekolah-sekolah di Malaysia.

INTRODUCTION

A review of recent study in Malaysia (Parmjit, 1998) suggests that possible problems in secondary school mathematics may be due to the procedural paradigm orientation in the curriculum and the conventional style of teaching in the classroom which do not provide sufficient opportunities for students to develop conceptual understanding. The current notion of school mathematics is based almost exclusively on formal mathematical procedures and concepts that, of their nature, are very remote from the conceptual world of the children who are to learn them. Many students see little connection between what they study in the classroom to real life. Just having students memorize facts and algorithms is debilitating. "Learning mathematics involves the construction of a network of meanings –relating one thing to another" (Wheatley, 1991). While students are memorizing facts, which could not possibly hold any meaning for them, they are not constructing relationships and patterns. In fact, they may 'stop thinking about mathematical relationship" altogether (Wheatley, 1991).

The current notion of ineffective practices which are prevalent in today's classroom are: teachers expecting students to learn mathematics by listening and imitating, teacher teaching as they were taught rather than as they were trained to teach, teachers teaching only what is in the textbooks, and students learning only what will be on the test. A study by Parmjit (1998) found that only a small percentage of students who did well on the national exam (PMR) were able to solve complex proportional problems and the grades obtained in this exam were not indicative of their knowledge of ratio and proportion. According to him;

> *The more we focus on raising test scores, the more instruction is distorted and the less credible are the scores themselves. Rather than serving as accurate indicators of students knowledge and performance, the tests become indicators of the amount of instructional time and attention paid to the narrow range of skills assessed.* (p. 107)

Basic computation skills have been the focus for competency tests, spawning textbooks and instructional emphases aimed at developing these skills. Students have learned how to do numerical computations at the expense of learning how to think and solve problems.

MATHEMATICS OBJECTIVES

The innovation of mathematics curricula has two main goals. The first goal is to reduce the descriptive nature of the discipline and to focus on fundamental principles, ideas and concepts. It is aimed at helping students construct a conceptual framework or structure on which they could build their scientific and mathematical knowledge.

The second goal is to employ the inquiry and guided discovery approach to the teaching of mathematics. This stems from the belief that for learning to be meaningful, learners need to construct and discover the principles and results themselves. In other words, approaches to new concepts should be through situations which are real, meaningful and relevant to pupils. Pupils are encouraged whenever possible to carryout their own investigation to discover for themselves techniques and results. Hence, practical activity is an important feature for these mathematics goals desired by the ministry.

Objectives for mathematics in Malaysian schools are to enables learners to develop the following characteristics (Education Ministry of Malaysia, 1998):

- Knowledge and understanding of mathematics
- Develop basic computation skills
- Follow algorithmic procedures in deriving the answer
- Become mathematical problem solvers
- Apply mathematical knowledge and skills to real life situations

If one looks at the goals of the curriculum, they look great and seem adequate to face the challenges for this century. However, this is not the case. The goals have not been able to realize the vision and expectation of its original proponent. There is little difference between the objectives (standard) of mathematics, methods of teaching and learning today and those which teachers used twenty years ago. Is this mathematics which is being used in schools in Malaysia adequately preparing students of the 2010's for life outside the classroom? There has been a dramatic change in the real world yet there has been little change in the mathematical learning process in Malaysia.

First of all, in concurring with the third objective, able to follow algorithmic procedures in deriving answers. School mathematics has become procedural because it reduces the cognitive demand or, more bluntly, allows students to get answers without thinking. Do we really want mathematics which de-emphasizes thinking?

I believe and I am convinced that many children have learned not to enjoy mathematics, and I do not blame them! If we look at the second objective namely developing basic computation skills, what is actually being taught presently on these skills is more memorization rather than understanding of facts. For example, in a linear equation **y = mx + c**, where **m** is the gradient and **c** the intersection of the y axis, students are able to find the **m** value but they are NOT able to give an interpretation or meaning of the **m** value. Another example in the lower primary, students are required and expected to memorize the multiplication tables, and I believe most students are able to do that. However, they are unable to give the meaning of, eg. A x B in the real life context and also to apply it to problem solving situations (Parmjit, 1998). These underlying concepts which are the basis of understanding mathematics becomes a secondary entity in learning and the algorithmic procedures in producing the product becomes the prime entity of learning. I am not saying that memorizing is not good but rather that emphasis should be more on the understanding of multiplication facts. As Price (1988) pointed out:

> *An algorithm is not of itself knowledge; it is a tool whose use is directed by mathematical knowledge and care must be taken not to confuse evidence of understanding with the understanding itself* (p.4)

Another question, which arises here, is the term "understanding" which has been quite loosely utilized in our system. What does this term means? As mentioned in the first objective, the main tenet for this is "the understanding of mathematics". When we discuss understanding, according to Skemp (1979), there are typically two types of understanding, namely instrumental understanding and relational understanding. There is no doubt that the present curriculum is based on understanding. But the question is what understanding are we emphasizing?

Relational understanding stresses mathematical relationships as opposed to instrumental understanding, which relies on remembered rules. As an example, it is certainly easier to remember that **the area of a triangle = ½ base x height** than to learn why this is so. Such learning requires remembering separate rules for the areas of triangles, parallelograms and trapeziums while seeing these areas in relation to that of a rectangle obviates this necessity. What I am trying to emphasize is that knowing how they are inter-related enables one to remember them as parts of a connected whole, which is easier. Instrumental mathematics (in today's curriculum) is usually easier to understand because it is based on easily remembered rules and easier to teach.

In short, children in Malaysia have experienced considerable failures in their attempt to learn concepts and skills. They have been asked to learn certain mathematical ideas that they were not ready to learn; they have been moved through a curriculum, ""learning" mathematics for which they did not have the prerequisites and struggling with new concepts that did not make any sense. They may have been pressured to memorize hundreds of unrelated basic addition and multiplication facts and subjected to timed tests in front of their peers. They believe that success in mathematics is knowing a certain "magical process" that results in correct answers. As a result, some children begin to dislike mathematics and do not want to do mathematics. Failure and humiliation are powerful forces that cause children to be reluctant to engage in mathematics. I believe that the mathematics classroom of recent years has been one of the most culturally-deprived environments inhibited by any Malaysian child; it has offered little beyond blackboard, chalk, pen, paper and textbook.

As started in the fourth objective, most textbooks in Malaysia do include sections on problem solving, usually presenting a five-or six-step approach to solving these "problems'. However, most of the content is still grounded in the "behavioral" approach to learning. These lessons teach the strategies their creators feel are necessary in solving problems, they have the students practice these strategies and they test to see whether the students have mastered them. In my experience, I've seen materials that present a strategy, and then show examples of problems that have been solved using the strategy. The students are then asked to practice using that same strategy on a number of contrived problems. For example in teaching exponents like this on the board:

$x^3 . x^3 = ?$

and letting each child in turn give an answer to a question of this type:

$x^1 . x^1 = x^2$

$p^1 . p^2 = p^3$

$x^2 . x^1 = x^3$

$x^3 . x^3 =$ ____

and so on.

Are we really teaching students exponents? I believe this methodology was straight out of Pavlov, and may possibly be the proper way to teach algebra to animals!! Human children "conditioned" this way learn so well that when they come to college, when they see **$x^3 + x^3 =$** ______ and respond (quite incorrectly) by saying "**x^6**", as many college mathematics teachers can testify.

This is a classic approach in teaching a skill. But problem solving is not a skill; it is a process, a way of thinking. It involves much more than a set of strategies that can be called upon and applied as needed. If we give them the strategies and set up problems for which we feel the strategies are best used, then we rob them of the essence of problem solving - thinking, analyzing and trying out ideas.

For the past 20 years much of mathematics curriculum practice in Malaysia as shown above, is conceived as the planned learning outcomes as represented by lists of quantifiable behavioral measures. It has been driven by the theory of behavioral psychology in which interaction between teachers and students has been defined in scientific terms like behaviorism. Such theory has driven the curriculum design process that starts with behavioral learning objectives, proceeds with content decision, and finishes with instructional methods. However, while behavioral theory derives its credibility from scientific knowledge about human behavior, it does not penetrate the complexity of what takes place when a person learns something meaningful. An alternative to the social efficiency model would be to adopt a human development/phenomenological design. This approach would be based on the needs of the learners; it would draw from the teacher's experience with and knowledge of, human development. In this case the planning or curriculum design sequence would start with an understanding of how people learn, continue with instructional methods that match learning styles and then progress to content.

The nature of instruction in the two cases may be appreciably different. In the first case the goals and objectives of learning come from experts who believe they know best what should be taught and how it should be taught. Such instruction is predicated on a top-down, linear model, in which knowledge is static and passed along or transmitted to the children. The second represents a blended model in which the needs of the student come first, knowledge is thought to be dynamic, and learning how to learn is as valid an outcome of schooling as the transmission of existing knowledge.

KNOWING AND LEARNING MATHEMATICS

What does it mean to know mathematics? I believe this is what's needed as a guiding philosophy what would suggest principle changes in the Malaysian mathematics curriculum in general. What it means to know mathematic emerges from the nature of mathematics. Thus, to know mathematics means to know patterns and relationships among patterns. The National Council of Teachers of Mathematics in the United States expands this notion very clearly and succinctly. The learner needs;

> *... to be able to discern patterns in complex and obscure contexts; to understand and transform relations among patterns; to classify, encode, and describe patterns; to read and rite in the language of patterns; and to employ knowledge of patterns for various practical purposes.* (1991, p.12)

By developing a philosophical basis for mathematics education as above, I believe it will influence the teaching of mathematics in Malaysian schools. Classifying mathematics as a science suggests that mathematics is actively explored through experimentation, discovery, manipulation, and discussion, and that calculators and computers can be used as tools of mathematics (being implemented to a certain extent). This view contrasts with the view that mathematics is only a paper and pencil exercise that relies on rules, formula and memory, as in the present situation. In short, merely utilizing technological tools in schools will not achieve its purpose in mathematics learning if we still view it as the planned learning outcomes represented by quantifiable behaviors.

At every level, learning mathematics should be a natural outgrowth of the children's lives. Learning should be interesting for the students, should challenge their imaginations, and should beget creative solutions in their art, music, movement and conversation. The discovery of mathematics should be devoid of boredom, meaninglessness and coercion. A proponent of teaching based on the principle of constructivism, Kamii(1989), notes that "Encouraging children to construct knowledge from within is the diametric opposite of trying to impose isolated skills from the outside". The approach that Kamii (1989, p.184) advocates contrasts with that of more traditional educators, who "... assume that the job of the teacher is to put knowledge into children's heads. They also assume that the proof of this transmission of knowledge is a high score on standardized tests. Both these assumptions ... are erroneous and outdated."

I believe that learning mathematics involves the construction of pattern and relationship and that successful use of "common' algorithm does not imply that the individual has constructed the mathematical relationship which accompanies the algorithm. I also believe that students who merely manipulate numbers via algorithm have not learned mathematics. However, I cannot deny that these students have been very successful in the formal school mathematics classroom by doing just that, memorizing algorithm and manipulating number. These students have felt successful and have labelled themselves and were labelled by others (teachers and parents) as good mathematics students.

In the broadest sense, learning mathematics serves as both a means and an end. Learning mathematics is a means of developing logical and quantitative thinking abilities. The key word is *thinking*. Thinking children are liberated from the dull routine that sometimes characterizes school. Learning mathematics is an end when students have developed basic computational skills and can apply mathematics to their world; that is, when mathematics becomes functional in the lives of children. At least a part of a young persons' environment can be explained by simple mathematical principles, as formulated in the fifth objective.

I believe that learning is a search for meaning. The purpose of learning is to construct one's own meaning, not to have the 'right' answers by repeating or replicating someone else's meaning. The important epistemological assumption of constructivism is that meaning is the function of how an individual creates meaning from his own experiences. We all conceive the external reality somewhat differently, based on our unique set of experiences with the world and our beliefs about them. At the heart of a constructivist approach to teaching is an awareness of the interaction between a child's current schemas and learning experiences, to look at learning from the perspective of the child and for the teacher to put himself in the child's shoes because knowledge cannot be transferred ready-made. To support the child to construct his own knowledge, discussion, communication, reflection and negotiation are essential components of a constructivist approach in learning and teaching.

In short, I believe that the Education Ministry of Malaysia should consider emphasizing constructivist-teaching methods in schools, especially in primary and lower secondary school mathematics. This is because we should strongly support a shift away from a teaching model based on the transmission of knowledge and towards a model based on student-centered experiences. Thus, the opportunity to employ alternative teaching approaches, including constructivist approaches, is at hand.

CONCLUSION

I had taught Middle and High school mathematics for the past 13 years and I thought I knew how to teach mathematics. I believe that mathematics, unlike most other subjects, is sequential and linear and can therefore best be taught through clearly defined, well-organized series of steps presented to students whom we have motivated to succeed. I felt good about my teaching, and I believed my students were getting excellent education, judging by their achievement.

My successful students were learning mathematics that served them well in high school. Students who did well in the skill-based curriculum I presented did well in the rigid skill-based high school curriculum, if one looks at their mathematics grades. The students were happy, I was happy and the school was happy.

Surely not everything is wrong with the current system but clearly something is amiss. The current model of learning that views the teacher as a dispenser, the student as passive receptacle, learning as accumulation, and knowledge as facts (cynically referred to as the tell-show-practice-test-and-forget model of learning) just doesn't produce mathematically powerful students. As much as I hate to admit it, I used this model for many years with hundreds of students, honestly believing that what I was doing was correct.

However, I now view learning in much broader terms than its approach implies. I believe the key to reform the mathematics education is utilizing the constructivist view of learning, which maintains that students learn by constructing their own knowledge. This approach is based on the notion that each learner brings to the learning situation different sets of belief and understanding based on prior experience. By engaging in activities in which he or she must construct learning by modifying previous ideas and beliefs, each learner comes away with a unique understanding of the concepts. This is not to say that mutual agreement is not important. Certain fact, processes, and concepts are universal, and we would like all students to share a common understanding of them. However, different students may bring to this understanding in different ways, depending on what they bring to the learning situation.

Improving mathematical education in the schools starts with improvements in the mathematical knowledge of the teachers. Teachers want students to understand what they are doing. What they mean by understand differs widely. When a teacher is preparing a lesson and is not totally comfortable with the mathematics involved, the lesson may reflect more of a procedural orientation. If a teacher doesn't see how a topic is situated in the larger body of mathematics and how these concepts interrelate, then their lesson is likely to become procedural. It requires a considerable depth of knowledge and comfort with the topics to be able to plan lessons which encourage students to construct their own knowledge.

Another aspect to be considered is if teachers could only accept the premise that the mathematical knowledge of their students is also valid, then the necessary adaptation of teachers when teaching mathematics would be in the direction of the mathematical knowledge of their students as well as in the direction of their own mathematical knowledge. In other words, the mathematical knowledge of the students as seen by their teacher would become part of the teacher's knowledge. This happy state of affairs could only improve mathematical communication in the classroom, especially in those cases where the teacher emphasized the activity of their students in learning mathematics.

In short, the purpose of education should be to teach students to think. The world is changing so rapidly that it makes no sense to ask students to memorize facts and theories that could change tomorrow. Instead, we must provide students with the learning environment in order to make them independent learners. The teacher's role is to develop and present problem-oriented curriculum, to stimulate reflection and thought, and to provide tools and strategies for managing and using information. There is a clear need for mathematics teachers to experience a change in the worldview of mathematics learning. The most fundamental job facing mathematics teachers is to foster the development of mathematical meanings in the students. Adopting the belief that mathematics is human activity and that mathematical learning is constructed as a result of such activity would be a step towards alleviating the influence, formalism and the abstracted symbolic presentation of mathematical rules and the procedures that it encourages. The belief can have far reaching consequences for mathematical teaching.

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