Contemporary Teaching in Mathematics

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Abstract

This paper reports on contemporary teaching in mathematics, perceptions of important elements of their role as teachers of mathematics at the conclusion of a two-year professional in life long. Analyses of written responses to survey items indicated shifts in four categories describing important elements of their role: teaching skills, knowledge, concepts; developing problem solvers; facilitating learning by providing quality activities, tasks, and resources; and fostering positive attitudes towards mathematics learning. Teachers attributed these perceived changes to the integration of a number of components within the project. Teaching is a complex craft involving many skills. It can also involve the artistry and enjoyment of combining these skills into cohesive and effective lessons that are productive learning experiences for students. But as indicated by Hargreaves (1994), teachers each play a key role in the learning experiences of the students they teach: Teachers don't merely deliver the curriculum. They develop, define it and reinterpret it too. It is what teachers think, what teachers believe, and what teachers do at the level of the classroom that ultimately shapes the kind of learning that young people get. We propose that few involved in teacher professional development would be in disagreement with Hargreaves as to the importance of teacher beliefs, along with other factors, for their potential impact on the learning experiences of students. Research indicates that beliefs are commonly seen to be stable but "can be held with varying degrees of conviction". with the consequence that the more central beliefs are resistant. On the other hand, this implies some beliefs may be open to change by outside influences. It is generally accepted that there is a relationship between teacher beliefs and teacher practice although researchers report varying degrees of consistency between teachers' professed beliefs and their actual instructional practices It is noted also that, although current documents encourage a view of mathematical activity as an active process.

INTRODUCTION

Simply stated, there is one main goal— the mathematisation of the child's thought processes. In the words of David Wheeler, it is "more useful to know how to mathematise than to know a lot of mathematics" 1. According to George Polya, we can think of two kinds of aims for school education: a good and narrow aim, that of turning out employable adults who (eventually) contribute to social and economic development; and a higher aim, that of developing the inner resources of the growing child .2. With regard to school mathematics, the former aim specifically relates to numeracy. Primary schools teach numbers and operations on them, measurement of quantities, fractions, percentages and ratios: all these are important for numeracy. What about the inner resources, the role that mathematics plays is mostly about thinking. Clarity of thought and pursuing assumptions to logical conclusions is central to the mathematical enterprise. There are many ways of thinking, and the kind of thinking one learns in mathematics is an ability to handle abstractions. Even more importantly, what mathematics offers is a way of doing things: to be able to solve mathematical problems, and more generally, to have the right attitude for problem solving and to be able to attack all kinds of problems in a systematic manner. This calls for a curriculum that is ambitious, coherent and teaches important mathematics. It should be ambitious in the sense that it seeks to achieve the higher

aim mentioned above rather than (only) the narrower aim. It should be coherent in the sense that the variety of methods and skills available piecemeal (in arithmetic, algebra, geometry).

Mathematical Teaching in Children:

Children learn to enjoy mathematics: this is an important goal, based on the premise that mathematics can be both used and enjoyed life-long, and hence that school is best placed to create such a taste for mathematics. On the other hand, creating (or not removing) a fear of mathematics can deprive children of an important faculty for life.

Children learn Important Mathematics:

Equating mathematics with formulas and mechanical procedures does great harm. Understanding when and how a mathematical technique is to be used is always more important than recalling the technique from memory (which may easily be done using a book), and the school needs to create such understanding.

Children See Mathematics:

As something to talk about, to communicate, to discuss among themselves, to work together on. Making mathematics a part of children's life experience is the best mathematics education possible.

Children Pose and Solve Meaningful Problems:

In school, mathematics is the domain which formally addresses problem solving as a skill. Considering that this is an ability of use in all of one's life, techniques and approaches learnt in school have great value. Mathematics also problems, and create new dialogues thereby.

Children use abstractions to perceive relationships, to see structure, to reason about things, to argue the truth or falsity of statements. Logical thinking is a great gift mathematics can offer us, and inculcating such habits of thought and communication in Children understand the basic structure of mathematics: Arithmetic, algebra, geometry and trigonometry, the basic content areas of school mathematics, all offer a methodology for abstraction, structuration and generalization. Appreciating the scope and power of mathematics refines our instincts in a unique manner.

PROBLEMS IN TEACHING AND LEARNING OF MATHEMATICS

Any analysis of mathematics education in our schools will identify a range of issues as problematic. We structure our understanding of these issues around the following four problems which we deem to be the core areas of concern:

1. A sense of fear and failure regarding mathematics among a majority of children,
2. A curriculum that disappoints both a talented minority as well as the non-participating majority at the same time,
3. Crude methods of assessment that encourage perception of mathematics as mechanical computation, and
4. Lack of teacher preparation and support in the teaching of mathematics.

Fear and Failure:

If any subject area of study evokes wide emotional comment, it is mathematics. While no one educated in Tamil would profess (or at the least, not without asense of shame) ignorance of any Tirukkural, it is quite the social norm for anyone to proudly declare that (s)he never could learn mathematics. While these may

be adult attitudes, among children (who are compelled to pass mathematics examinations) there is often fear and anxiety. Mathematics anxiety and 'math phobia' are terms that are used in popular literature.11 In the Indian context, there is a special dimension to such anxiety. With the universalisation of elementary education made a national priority, and elementary education a legal right, at this historic juncture, a serious attempt must be made to look into every aspect that alienates children in school and contributes towards their non-participation, eventually leading to their dropping out of the system. If any subject taught in school plays a significant role in alienating children and causing them to stop attending school, perhaps mathematics, which inspires so much dread, must take a big part of the blame.

Inadequate Teacher Preparation:

More so than any other content discipline, mathematics education relies very heavily on the preparation that the teacher has, in her own understanding of mathematics, of the nature of mathematics, and in her bag of pedagogic techniques. Textbook-centred pedagogy dulls the teacher's own mathematics activity. At two ends of the spectrum, mathematics teaching poses special problems. At the primary level, most teachers assume that they know all the mathematics needed, and in the absence of any specific pedagogic training, simply try and uncritically reproduce the techniques they experienced in their school days. Often this ends up perpetuating problems across time and space. At the secondary and higher secondary level, some teachers face a different situation. The syllabi have considerably changed since their school days, and in the absence of systematic and continuing education programmes for teachers, their fundamentals in many concept areas are not strong. This encourages reliance on 'notes' available in the market, offering little breadth or depth for the students. While inadequate teacher preparation and support acts negatively on all of school mathematics, at the primary stage, its main consequence is this: mathematics pedagogy rarely resonates with the findings of children's psychology. At the upper primary stage, when the language of abstractions is formalised in algebra, inadequate teacher preparation reflects as inability to link formal mathematics with experiential learning. Later on, it reflects as incapacity to offer connections within mathematics or across subject areas to applications in the sciences, thus depriving students of important motivation and appreciation.

Contemporary Teaching Manners in Maths:

It is worth explaining the kind of processes we have referred to and their place in the curricular framework. Admittedly, such processes cut across subject areas, but we wish to insist that they are central to mathematics. This is to be seen in contrast with mathematics being equated to exact but abstruse knowledge with an all-or-nothing character. Formal problem solving, at least in schools, exists only in the realm of mathematics. But for physics lessons in the secondary stage and after, there are no other situations outside of mathematics where children address themselves to problem solving. Given this, and the fact that this is an important 'life skill' that a school can teach, mathematics education needs to be far more conscious of what tactics it can offer. As it stands, problem solving only amounts to doing exercises that illustrate specific definitions in the text. Worse, textbook problems reduce solutions to knowledge of specific tricks, of no validity outside the lesson where they are located. On the other hand, many general tactics can indeed be taught, progressively during the stages of school. Techniques like abstraction, quantification, analogy, case analysis, reduction to simpler situations, even guess-and-verify, are useful in many problem contexts. Moreover, when children learn a variety of approaches (over time), their toolkit gets richer and they also learn which approach is best when. This brings us to the use of heuristics, or rules of thumb. Unfortunately,

mathematics is considered to be 'exact' where one uses 'the appropriate formula'. To find a property of some triangle, it is often useful to first investigate the special case when the triangle is right angled.

Mathematics is not Just Arithmetic:

While addressing number and number operations, due place must be given to non-number areas of mathematics. These include shapes, spatial understanding, patterns, measurement and data handling. It is not enough to deal with shapes and their properties as a prelude to geometry in the higher classes. It is important also to build up a vocabulary of relational words which extend the child's understanding of space. The identification of patterns is central to mathematics. Starting with simple patterns of repeating shapes, the child can move on to more complex patterns involving shapes as well as numbers.

Number and Number Operations:

Children come equipped with a set of intuitive and cultural ideas about number and simple operations at the point of entry into school. These should be used to make linkages and connections to number understanding rather than treating the child as a tabula rasa. To learn to think in mathematical ways children need to be logical and to understand logical rules, but they also need to learn conventions needed for the mastery of mathematical techniques such as the use of a base ten system.

Fractions and Decimals:

Fractions and decimals constitute another major problem area. There is some evidence that the introduction of operations on fractions coincides with the beginnings of fear of mathematics. The content in these areas needs careful reconsideration. Everyday contexts in which fractions appear, and in which arithmetical operations need to be done on them, have largely disappeared with the introduction of metric units and decimal currency. At present, the child is presented with a number of contrived situations

Mathematics for All:

A systemic goal that needs to be underlined and internalised in the entire system is universal inclusion. This means acknowledging that forms of social discrimination work in the context of mathematics education as well and addressing means for redress. For instance, gendered attitudes which consider mathematics to be unimportant for girls, have to be systematically challenged in school. In India, even caste based discrimination manifests in such terms, and the system cannot afford to treat such attitudes by default. Inclusion is a fundamental principle. Children with special needs, especially children with physical and mental disabilities, have as much right as every other child to learn mathematics, and their needs (in terms of pedagogy, learning material etc) have to be addressed seriously. The conceptual world of mathematics can bring great joy to these children, and it is our responsibility not to deprive them of such education. One important implication in taking Mathematics for all seriously is that even the language used in our textbooks must be sensitive to language uses of all children.

Teacher Support in Mathematics:

The systemic changes that we have advocated require substantial investments of time, energy, and support on the part of teachers. Professional development, affecting the beliefs, attitudes, knowledge, and practices of teachers in the school, is central to achieving this change. In order for the vision described in this paper to become a reality, it is critical that professional development focuses on mathematics specifically. Generic 'teacher training' does not provide the understanding of content, of instructional techniques, and of critical issues in mathematics education that is needed by classroom teachers. There are many mechanisms that

need to be ensured to offer better teacher support and professional development, but the essential and central requirement is that of a large treasury of resource material which teachers can access freely as well as contribute to. Further, networking of teachers so that expertise and experience can be shared is important. In addition, identifying and nurturing resource teachers can greatly help the process. Regional mathematics libraries may be built to act as resource centres.

Mathematics and Mathematicians:

At all stages of the curriculum, an element of humanizing the curriculum is essential. The development of mathematics has many interesting stories to be told, and every student's daily life includes many experiences relevant to mathematics. Bringing these stories and accounts into the curriculum is essential for children to see mathematics in perspective. Lives of mathematicians and stories of mathematical insights are not only endearing, they can also be inspiring.

CONCLUSION

In a sense, all these are steps advocated by every mathematics educator over decades. The difference here is in emphasis, in achieving these actions by way of curricular choices. Perhaps the most compelling reason for the vision of mathematics education we have articulated is that our children will be better served by higher expectations, by curricula which go far beyond basic skills and include a variety of mathematical models, and by pedagogy which devotes a greater percentage of instructional time to problem solving and active learning. Many students respond to the current curriculum with boredom and discouragement, develop the perception that success in mathematics depends on some innate ability which they simply do not have, and feel that, in any case, mathematics will never be useful in their lives.

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