Is School Mathematics All about Recipes for Calulation?

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The dubious claims made in the name of 'Vedic Mathematics' and the dangers in accepting these claims at face value, have been laid bare in some detail by Dani in an article which is available on the web.[1] Pride in the achievements of ancient Indian mathematicians is fully justified, since there have indeed been great achievements. But, as Dani argues, propagating elementary work, which has no authentic historical basis, as a significant contribution to mathematics is to seriously erode intellectual culture and create a kind of hubris. This will eventually blind us to genuine achievements and render us incapable as a culture of achieving greatness. I will not repeat more of Dani's arguments although I agree with them. I will restrict myself here to the specific pedagogical and educational claims made on behalf of the so-called 'Vedic Mathematics'(henceforth, SC-VM).

In the foreword to a SC-VM school textbook, it is claimed that SC-VM is a 'sophisticated pedagogic and research tool'.[2] It is the claim about the pedagogical superiority of SC-VM that I will address here. I will examine this claim by discussing two well-known school textbook series of SC-VM.

An influential article [3] was published in 1973 in a mathematics education journal which reported a study of how Benny, a 6th grade student in the U.S., understood fractions and decimals. While Benny did well in many parts of arithmetic, he had made up his own rules about how to add fractions and decimals or convert between them, which led him sometimes to the right and sometimes to the wrong answers. For example, according to his rules $\frac{5}{10}$ was equal to 1.5, so was $\frac{4}{11}$ and $\frac{11}{4}$. $\frac{1}{8}$ was 0.9 and $\frac{27}{15}$ was 4.2. Although this may be mystifying, a little examination shows that Benny was consistently applying the rule $\frac{(ab)}{c}$ = a.(b+c) where the dot on the RHS is the decimal point. He used similar idiosyncratic rules for adding decimal numbers. Benny made very little progress when the researcher gave him remedial instruction for two months.

The important finding of the study was not these rules, which a teacher anyway commonly encounters, but Benny's understanding of mathematics that lay behind these rules. Benny did reasonably well on intelligent tests (IQ test score of 110-115) and was thought by his teachers to be making reasonable progress in mathematics. He could argue about and justify his answers and was very concerned about getting answers right. What the reseacher found was that he had an idea of mathematics as purely made up of rules. He had no sense of the underlying structure of arithmetic which made rules correct or wrong. So he tolerated inconsistency, and tried his best to make up rules which produced the answers in the answer key.

The article was something of a wake-up call to mathematics educators in the US, who were in the middle of one of the periodic pendulum swings in American school mathematics education, this time, the 'back to the basics' swing. It reminded the community of the dangers of teaching mathematics as merely a collection of rules or recipes. Indeed this

[1] Dani, S.G. 'Myths and Reality: On Vedic Mathematics, An Updated Version of the 2-part Article Published in Frontline, 22nd Oct and 5th Nov, 1993. Available on http://www.math.tifr.res.in/d̃ani. Retrieved on 2-12-2007.

[2] Williams, K. and M. Gaskell, *The Cosmic Calculator: A Vedic Mathematics Course for Schools, Book 2.*, Motilal Banarsidass, 2002, p.v.

[3] Erlwanger S. H.: 1973, 'Benny's concept of rules and answers in IPI mathematics', *Journal of Children's Mathematical Behavior* 1: 726.

point had been recognized by educators and educational psychologists for a long time. One of the major problems of mathematics education in many places, and especially in India, is the emphasis on rote learning of rules and procedures. A study of student achievement in mathematics and science in leading schools in the major Indian metros conducted last year, which was reported in the media, sheds some light on the magnitude of the problem.[4]

The much touted 'Vedic Mathematics' is just another recipe based approach to teaching mathematics. In fact, the situation is worse. We find that the best-known school textbooks adopting the 'vedic' approach are just a haphazard organization of recipes and exercises, with scant attention paid to developing concepts or any understanding. In this respect, they compare poorly with some of the standard textbooks used in Indian schools. The cause for this is not difficult to find. The original inspiration for these efforts is the book titled 'Vedic Mathematics' written by Swami Bharati Krishna Tirtha. The serious shortcomings of the book and the lack of honesty reflected in the title and in several of the author's claims have been pointed out by Dani (ibid.). It is not surprising that the school textbooks of 'Vedic Mathematics' are in the same 'recipe' genre and are lacking in rigour and use language in a careless manner.

I'll briefly describe the way the topic of fractions is treated in some textbooks on Vedic Mathematics meant for schools, since this is an important topic in the school curriculum and quite difficult for many students. The two school textbook series on 'Vedic Mathematics' that are well advertised (for example on several vedic mathematics websites) are those written by Kenneth Williams and Mark Gaskell and those by James Glover. Both these books were published in the U.K. and are now available in Indian editions published by Motilal Banarsidass.[5,6]

First let us look at the Book 2 of the series by Williams and Gaskell. Presumably some work with fractions has been done in Book 1. The chapter on Fractions in Book 2 begins with a definition of numerator and denominator (top number and bottom number). Then it defines a 'top-heavy' fraction (numerator greater than denominator) and says that such are also called improper or vulgar fractions (Williams and Gaskell, p.13). There seems to be a confusion of terminology here – the term 'vulgar fractions' in standard textbooks, and also in the book by James Glover, is used to denote fractions which are not decimal fractions, and includes proper and improper fractions. Then we find the following sentences: 'Top-heavy fractions are always greater than a whole one.' And below that we find 'A number like $1\frac{3}{4}$ is called a mixed number because it is a mixture between a whole number and a fraction.' The phrases 'a whole one' and 'mixture between' hardly clarify and can in fact generate confusion.

Standard exercises on fraction computations and conversions follow where nothing is explained clearly. There is no 'vedic mathematics' here. What is there is standard stuff, presented in a slipshod manner, with no attempt to clarify concepts or their connections with other concepts in arithmetic. Much of the book, which has a grand sounding title 'Cosmic Calculator', is in the same vein. The brief single paragraph introduction to mathematics gives a preview of the careless manner in which the whole book is written. The

[4] http://www.ei-india.com/full-report.pdf

[5] Williams, K. and M. Gaskell, *The Cosmic Calculator: A Vedic Mathematics Course for Schools, Books 2 and 3.*, Motilal Banarsidass, 2002.

[6] Glover, J.T., *Vedic Mathematics for Schools, Books 2 and 3.*, Motilal Banarsidass, 1999.

introduction declares,

"Mathematics evolves in three main branches: Arithmetic, Algebra and Geometry. Arithmetic deals with numbers, of which there are many types. Numbers have various properties and can be combined in various ways." So far nothing very worrisome, but it goes on to say, "Algebra deals with symbols, often the letters of the alphabet. These also have their own special properties and can be combined."(Williams and Gaskell, Book 2, p.vi). Such statements perpetuate misconceptions in the students' minds that algebra deals with objects that are entirely different from arithmetic and that it deals with the properties of letters.

The books by James Glover are not very different. Book 2 of the series begins with the following profound declaration.

"Number begins at one which is an expression of unity. Just as our lives may become easier and happier by coming under one law, so many arithmetic problems are made easier by relating the numbers back to unity or one." (Glover, Book 2, p. 1)

It goes on to say, "in the number system there are only nine numbers and a zero or nought. With these we can display all multiplicity. In counting, once we are past the number ten then the numbers repeat themselves. the points where the repetitions begin are 10, 100, 1000, etc. These numbers, one with any number of zeros following, also represent the unity from which number begins." (ibid.)

Would you recommend a book with such imprecise statements as a mathematics text-book for your school? Any standard textbook followed in an Indian school would be more careful to distinguish between numbers, numerals and digits, and between the repetition of numbers and the repetition of a pattern.

Let us go to the chapter on fractions (Chapter 6). It begins thus "Common or vulgar fractions arise from *pretending* to divide the one which is unity. The line in between the two numbers in the fraction stands for the division sign. Thus, for example, $\frac{3}{5}$ represents the division $3 \div 5$" (emphasis added). We find here the important definition of a fraction as a quotient, but together with some confusing phrases thrown in. However the rest of the book is completely silent about the connection between fractions and division and the work with fractions is done entirely by treating them as parts of a whole or of a quantity. The sentence is then taken up in book 3, which the student will probably meet after a year and the following unhelpful explanation is offered: "This name ['vulgar fraction'] is used to indicate that the division of one number by the other has not taken place and is therefore rough, common, unrefined, or vulgar." After this explanation for why fractions are vulgar, Book 3, just like Book 2, fails to mention the connection between fractions and division again.

The rest of the chapter on fractions in Book 2 (and also in Book 3) presents only procedures for standard operations with fractions one after another. The 'vedic' element appears only once, in the form of the 'transpose and adjust' sutra which is mentioned as part of the procedure for dividing by a fraction (the 'invert and multiply' rule). There is no explanation or justification of the 'invert and multiply' division procedure. Just the recipe is presented with the sutra as an add-on. Why is 'transpose and adjust' not applied to multiplication or to addition or subtraction? Of course, 'transpose and adjust' makes an entrance again while solving simple equations, where it has nothing to do with fractions. The authors naively assume that students can be simply programmed to apply the right rule in the right circumstances.

Infact, there is very little of SC-VM in Book 3 of the series by James Glover. Almost all of the content is what would be found in a standard school mathematics textbook at roughly grade 8 level. There is a minimum sprinkling of a few shortcut rules from vedic mathematics at places. Apart from this the exercises and the explanation are standard and routine, and not particularly interesting, despite the praise that is heaped on the book in the blurb on the back cover.

All these indicate the poverty of the so-called 'Vedic mathematics' of Bharati Krishna in delivering a wholesome school mathematics curriculum. Much of the attention given to the fad is driven by parents' anxiety about the success of their children in school. This anxiety is what drives various educational fads in the marketplace. If parents are not reflective and critical, they may end up doing more harm to their children than good, despite their intentions.