UNIVERSAL ACTIVE MATH

A PROGRAM FOR PRIMARY MATH UNIVERSALIZATION

Dr. Vivek Monteiro
Navnirmiti

Geeta Mahashabde
Navnirmiti

Is universalisation of primary school math possible? Here we examine how and why this is possible. What do we mean by universalisation of primary math? What are the problems which have to be solved for achieving this? What is a pedagogy for math universalisation? What systems are necessary for mass implementation? This paper discusses the Universal Active Math programme with its two-stage pedagogy of understanding by doing, followed by translation into the conventional alphanumeric language. It argues that all the necessary inputs are available today.

The Problem

What do we mean by universalisation? We adopt the official criterion of 85x85. Eighty five percent of children of a given class level should be proficient in at least 85 percent of the math competencies prescribed in the national/state curriculum for that class level. In India, where access to education is a constitutional right for all citizens between the age of 6 and 14, achieving universalisation of primary math would require approximately 15 million children to graduate out of primary school each year with proficiency in math.

By proficiency in math at a given class level we mean that the student should be comfortable with the math concepts, should be able to correctly perform the math skills and operations and should be able to correctly represent and transform simple real life problems into math problems at that level. The student should have two-way translation skill, representing real life problems with things and in numbers and narrating a real life situation for a given math expression. Basically the child should be comfortable and able to work with the counting numbers of upto three and more digits, performing the basic operations of addition, subtraction, multiplication and division with these numbers, and should understand and be able to work with fractions and decimals. The child should understand simple measurements and should be introduced to basic sizes and shapes for geometry.

A Pedagogy for Primary Math Universalisation

Achieving universalisation in India, would necessitate that each year 18 million children enrol, and remain in primary school and that 85% or more of these children achieve an understanding of math which makes them comfortable with it. This in turn would require that close to 100 percent of primary school teachers in the country be comfortable with primary math. Is this possible? We believe that it is. But it will require the solution of problems at two levels: the pedagogical and the logistical. We begin with a discussion of the pedagogical problem.

The pedagogical problem of primary math universalisation can be addressed if every child learns math by understanding and only by understanding. This requires a solution of problems at both the conceptual level as well as at what we may call the' math linguistic' level.

The Math Linguistic Problem

Math has many languages: thing language, the language of actions, individual and group activity, the language of shape and size, picture language, sound language… and of course, the language of pencil and paper, slate board and chalk, of numerals and symbols. We may term this latter language as the alphanumeric language of math.

Alphanumerics is not mathematics. It is only one of the languages of math. For children, the alphanumeric language is a new and unfamiliar language. The difficulty that children have with primary math is mainly at the math linguistic level with the alphanumeric language and not at the conceptual level.

A Two-Stage Process

Therefore the learning process must be broken up into two stages. First, the stage of conceptual understanding, where the child learns and understands the concept in a familiar language. The second stage is the stage of translation of this understanding from the familiar language into the alphanumeric language. Over the four years of primary school, the child steadily develops familiarity with the alphanumeric language (representation). To that extent, towards the end of primary school, one can increasingly work directly with alphanumerics as the child develops familiarity with this math language.

Things language, actions language, the language of shape and size, are universal and familiar languages for children. These are the languages in which the child must first encounter a new concept. This is illustrated with two examples.

Since Addition is Joining, Multiplication gives Rectangles.

Almost all of primary mathematics can be built on a single concept which is: Addition is joining. Things can be joined. Shapes can be joined. With jodo blocks (a math manipulative) the child learns how to represent 3+1 and 2+2. With jodo blocks the child also learns to use the symbols >, < and = which represent bigger, smaller and same size. With this the child can discover that 3 + 1 = 4, in the language of things. After achieving complete familiarity and understanding with these operations of joining and comparing, the understanding can be translated into alphanumerics. Addition is thus discovered by a process of doing and discovering. All of primary math can be traversed by a process of performing activities, working with things, and problem solving in a carefully designed sequence.

Multiplication is the repeated addition (joining) of the same number to itself. When a number is joined to itself sideways repeatedly, it generates a shape which is a rectangle. Using Diene's blocks (base-ten blocks) we begin by discussing how multiplication of two single digit numbers can be performed in things language by making rectangles. Through a carefully structured sequence of problems the children discover how to multiply two digit numbers in things language using unit cubes, rods and plates. This thing language representation is then readily transformed into a pictorial representation - which is a pen and paper representation. Some more practice with multiplication in the pictorial representation, and the discovery of rules of simplification leads the student to discover the traditional alphanumeric techniques of multiplying two and three digit numbers.

Universal Active Math

The above two examples, which are discussed in some detail, are only specific illustrations of a comprehensive and general method: Learning a new concept by a structured sequence of solving problems with things, shapes and sizes. When conceptual understanding is gained and consolidated in this familiar language, the second stage of translating into pen and paper representations of pictures and alphanumerics is achieved by another structured sequence of problem solving.

In the first stage the children construct material structures in a manner which facilitates the formation of appropriate mental structures. In the second stage they are helped to translate these mental structures into the structures of the alphanumeric language.

With this two-stage approach it is possible to make every mainstream student understand and be comfortable with all the competencies of primary school math upto fractions and decimals. Thus we can propose and construct a comprehensive pedagogy for universalisation of primary math, which we call Universal Active Math.

The term 'Universal' here has three different connotations. Firstly, a pedagogy for achieving universalisation under existing real conditions. Secondly, the use of a universal language- the language of things, for the child's first encounter with a new concept. Thirdly, math as a universal language of the natural and social sciences.

Pedagogy by itself will not result in universalisation. Universalization is something much more than subject enrichment in the classroom. It necessitates systems for mass implementation and rigorous methodology. Whether at the district level, state level or national level, progress, or lack of it, towards universalisation, has to be continuously and objectively assessed. In math this can be done quantitatively, accurately and rigorously.

SOPs and Systems for UAM

The logistical aspect is no less important than the pedagogical aspect. For building a mass programme, the pedagogy is converted into standard operating practices (SOPs), incorporating the best practices available locally, nationally and internationally for each concept and competency. For each class this is converted into 150 hours of instruction in an academic year. A teacher's manual and accompanying students' workbooks ensure that the SOPs are implemented in proper sequence. Our experience in implementing this programme in hundreds of schools has emphasized the need for continuous school and classroom visits by a math facilitator to help the teacher. Where the programme has been rigorously implemented average achievement levels have reached the norms defining universalisation over a span of four years.

Accountability at all levels

The mass participation of the teacher community is, of course, critical to achieving universalisation. But it is also important to highlight the role of other stakeholders. With universalisation of primary education becoming a constitutional mandate in India it is necessary for every stakeholder to be held accountable for its function, including the governmental education departments and their functionaries, the school administrations, the teachers community, the organizations promoting quality interventions and the private initiatives which are part of corporate social responsibility.

Given the commitment and accountability of all major stakeholders, it is possible to conceive a nationwide systematic programme which will over a period of four years cover all four classes of primary school. But how can thousands of teachers be trained for a program on this scale?

Teacher training

Teacher training necessary for this programme consists of one week intensive training followed by one-day sessions every six weeks. The strength of the learning by doing approach, which is the cornerstone of the universal active math, is that teacher skills continuously improve as they implement the programme. Once initiated, the system can constantly improve through this process. Though there is a standard math kit developed for this programme, learning in things language can also be built around everyday low cost and no cost materials developed locally. Modern technology of information and communication including CDs and internet, along with the traditional print media can ensure that teachers have access to high quality teachers manuals at low cost.

All necessary inputs for universalisation of primary math are therefore available.