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ABSTRACT

This paper compares and analyzes preschool mathematics education in Singapore and India in terms of strategies, learning activities, teacher expectations, and parental involvement. The paper describes the mathematics curriculum of one school in Erode, India, including teaching methods, and in Singapore. The results of a parent survey in each country are presented, highlighting different parental attitudes toward mathematics education, math achievement for boys and girls, parental involvement in math education, and classroom instruction. (JPB)

ACEI 1999 paper abstract

Mathematics Curriculum in India and Singapore

Approach to teaching mathematics in preschool classrooms around the world varies a great deal. The cultural expectations and societal pressures of learning and teaching mathematics play an important role in what curriculum standards are set for schools. Some countries introduce children to mathematical concepts very early in a structured manner and expect certain performance level and standards . The curriculum may appear to be rigid but encourages and challenges children to exercise their spatial-numerical thinking by providing appropriate activities. A few other nations feel that mathematics should be taught only by exposing young children to mathematical concepts through play and hands-on experiences.

In international comparisons, students in Singapore have ranked high above some industrialised countries in mathematical skills while in India, mathematics seems to present the most challenge to school teachers. Public alarm generated by the consistently low performance of children has led to many recommendations for improvement. In this presentation, the various ways mathematics is taught in the preschools in Singapore and India will be compared and analysed in terms of strategies, learning activities, teacher expectations and parental involvement. Two short surveys from the two countries will be highlighted.

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Mathematics Curriculum in India

Mathematics is a highly revered subject in Indian culture. Most parents want their children to excel in mathematics since proficiency in mathematics has always been viewed as an indicator of one's intellectual ability. This is not surprising considering India's long history of excellence in mathematics. In this century India has produced one of the greatest mathematics of all time, Ramanujum. However for most Indian children in their early school years mathematics is an anathema. This is unfortunate because mathematics learning can be a joy and a creative process if only parents and teachers take the right approach to teaching the subject.

In India, federal and state governments fund programs for poor children in both rural and urban areas. Such programs mainly address health, safety and nutrition issues and these provide healthy food and a safe environment for children to play and grow while their parents are out at work. "Balwadi" is one such center for young children where trained teachers/volunteers attend to children's needs while parents are away. In some areas the government has "anganwadi workers" (childcare providers) who are carefully selected based on their aptitude and are trained in age appropriate expectations and in creating a learning environment that fosters child's creativity. There is no educational qualification prescribed for the anganwadi workers.

In terms of teacher preparation, there is a paradigm shift occuring in the way mathematics is taught in schools amidst a growing awareness among teachers as to how children learn. Teaching children the basic concepts through exploration has been the major focus of teacher preparation and the education department of the government organizes all-day workshops to accomplish this goal. The training emphasizes how children learn and why play is important in the early childhood period. Teachers learn how to create a learning environment and how to be innovative and creative in problem solving. More schools are adopting the developmentally appropriate teaching methods. Nonetheless, learning new techniques poses a challenge to teachers, as it requires unlearning their old habits to pave way for the new.

The schools that have made the move to the new approach are committed to improving instruction, creating an age appropriate learning environment for children and encouraging professional development of their teachers. One has to be culturally sensitive to the term "age appropriate" as it means different expectations for different cultural groups. The following description is based on a visit to a school in Bharathi Vidya Bhavan in Erode, south of Madras.

Mathematics Curriculum

The mathematics curriculum in the kindergarten classes in this school is unstructured. In the lower kindergarten, a preschool for the three year olds, the chidren are exposed to the following:

One-to-one correspondence of numbers and objects; counting 1 up to 10; opposite terms such as heavy and light, more and less.; classify and sort shapes, sizes and colors; match animals and their babies; floor and board puzzles.

In the upper kindergarten for four year olds, the children are taught by 'playway methods' to do the following:
Count and recognize numbers up to 100; write numbers 1 up to 20; sort, match and classify shapes, sizes and colors; recognize basic shapes; comparison:more/less, full/empty; count in second language 1-20; addition with manipulatives; memory games; children in these classes are not given any homework.

Curriculum becomes more structured in grade 1. They are taught the following concepts: Greater than and less than; before and after; two digit addition and subtraction; addition tables up to 10000; time; shapes; simple word problems.

Teaching Methods

The use of manipulatives to teach math has made its way into the classrooms here. Mathematics laboratory and computers for children are no longer a dream. Children have more exciting experiences to look forward than just paper, pencil and worksheets. Homework for the lower kindergarten and upper kindergarten have become a less common occurrence now. This has taken the pressure off from parents, as they no longer have to supervise young children complete their homework. There is playtime for children in both school and at home.

Structured math curriculum is introduced in the first grade classroom. Memorizing addition tables are emphasized in the first grade. The children from upper kindergarten onward are taken to a math laboratory to learn new concepts in the subject. The school makes a conscious effort to keep their teachers current on teaching methods and offer plenty of opportunities for them to grow professionally. There is an academic advisor for teachers whose responsibility is to train teachers on new methodologies in teaching and to discuss classroom issues.

Children in this school visit the math laboratory once a week where there is a host of manipulatives and other teaching aids for the their use. The math teacher at the lab is trained in the use of different manipulatives and uses innovative methods for teaching concepts to children. A group of four children are seated around each child-sized table where the lab teacher lays out manipulative individual trays for the children's use. The teacher introduces new concepts to children by asking them open-ended questions and asks them to explore the manipulatives. Often times she uses a word problem to get the children to think about the concept and asks them to solve either individually or in cooperation with the group mates depending upon the question asked.

Once the question is posed the lab teacher along with the class math teacher encourages children to discuss or sits down with children who need additional support.

The teachers encourage speed and accuracy in children's responses if it is a revision of concepts. Peer tutoring is not an unheard of concept any more. The child who finishes the task gets to help others. The Bhavarthi Vidya Bhavan is one of the very few schools in India to have such a well-equipped lab with well trained staff. It conducts a monthly assessment test to evaluate the children's understanding of concepts taught. This tool is also used to identify children who have not understood the new lessons. These children are then given additional lessons to help them learn the concept so they can catch up with the class.

The computer is not an integral part of the curriculum due to its prohibitive costs but a 'pullout' model is used to expose children and to give hands-on experience in computer on a weekly basis. The children walk over to the computer lab where the lab technician explains what the children are expected to do and offers general guidelines regarding its use.

Parent Survey

A group of 50 randomly selected parents in the school were given a questionnaire on how they view mathematics education. 98% of the questionnaires were returned and their responses gave an interesting insight into how parents view mathematics education. Many were aware of the new thinking that children learn by exploration and by constructing their own knowledge. The following were some of the parents' responses to the questions asked.

Question 1: What are your expectations for your child in mathematics?
Parents of children in first grade have the following expectations: memory, speed, proper understanding of concepts, independence, numerical abilities and a natural inclination and interest for the subject. Almost all parents expect their child to be thorough with tables. The overwhelming response focused on the child scoring 100% in maths, being excellent and first in class. An interesting comment made by parents who are both physicians about their expectation for their daughter is that they have planned her future to be in computer science and therefore she will have to do exceedingly well in math.

Parents from the upper kindergarten have varied expectation. Four out of seventeen parents feel that their child acquiring basic knowledge and skills are important. Five of them expect their child to be outstanding and excellent in math. One of them expects her child to be a genius in math. In addition to these comments there are some that stress speed, interest, solving simple additions, number names and counting. It was heartening to note that six parents from the lower kindergarten want their children to enjoy math and have 'fun'. Understanding basic concepts and counting numbers are important to many.

Question 2: Are your expectations different for your daughter and son? How?
Contrary to what the media portray most parents say that their expectations have no gender bias. A few stress that they will count on individual differences and not the sex of the child to determine their expectations..

Question 3: Do you help your child do his/her homework?
The kindergarten children are not given any homework. However, parents gave hypothetical responses. The responses are equally divided between those parents who would sit with their child to help him/her accomplish the task and those who want their child to be independent. Some parents mentioned that they give homework themselves for the child to practice handwriting and explain doubts. Parents of first grade students are anxious about their child learning the tables correctly and therefore they make them recite the tables everyday. Most of them state that they ensure that the child do the sums correctly. A great many of them value their child's understanding of concepts more than the mechanical process of completing the homework.

Question 4: What math activities do you do with your child at home?
'Teaching with manipulatives" is the overwhelming response from parents to this question. They use a wide variety of items available in the home environment to teach different concepts such as simple additions, subtractions and counting. They use vegetables, fruits and sweets to help the child understand simple concepts. Some use the TV and buses to help the child identify numbers. Parents of first grade focus on helping the child learn tables and do mental sums in playful ways, involving them in solving puzzles and riddles. They use computer games and calculators to help their children understand concepts taught in school

The parents in this survey are from a very educated group. Except for one parent, a father, all the others have either a bachelors or masters degree. Six of the couples are doctors. A few are attorneys and businessmen. Most of them expect their children to do exceedingly well in math. One group believes in using age appropriate methods and to work with the school to help the child. The whole family is willing to support the child achieve his/her potential.

Mathematics Curriculum in Singapore

The mathematics curriculum in Singapore has been officially developed and refined since the early nineties by the Ministry of Education and has been used as a guide for teachers to plan their math program. Teachers are not bound by the choice and sequence of topics presented but are ensured that the heirarchy and linkage within the curriculum are maintained. They are encouraged to exercise flexibility and creativity when using the curriculum.

The aims of mathematics education for the primary grades are to enable children to acquire the necessary mathematical knowledge and skills, to develop thinking processes and to apply them in mathematical situations that they will meet later in life. Children are encouraged to use mathematics as a means of communication, to develop positive attitudes and a sense of personal achievement in mathematics and to appreciate the importance and power of mathematics in the world around them. Primarily the

mathematics curriculum hopes to develop in children mathematical problem solving abilities covering a wide range of situations from routine mathematical problems to open-ended investigations that make use of relevant mathematics.

The attainment of mathematical problem solving skills is dependent on five inter-related components–concepts, skills, processes, attitudes and metacognition.

Mathematical Concepts refer to the basic mathematical knowledge needed for solving mathematical problems. They include notions of numerical , geometrical, algebraic and statistical concepts.

Mathematical Skills refer to the topic-related manipulative skills that children are expected to perform when solving problems. They include estimation and approximation, mental calculation, communication, use of mathematical tools, arithmetic manipulation, algebraic manipulation and handling data.

Mathematical Processes refer to the thinking and heuristics involved in mathematical problem solving. They cover three aspects such as deductive reasoning (logical thinking, deducing new information from existing information and drawing conclusions); inductive reasoning (recognising patterns and structures in mathematics and forming generalisation) and heuristics for problem solving (strategies such as 'using diagrams' 'using tabulations' 'making suppositions' 'looking for patterns' 'working backwards' and 'solving part of the problem').

Mathematical Attitudes refer to the affective aspects of mathematics learning such as enjoying doing mathematics, appreciating the beauty and power of mathematics and showing confidence in using mathematics.

Mathematical Metacognition refers to the ability to control one's own thinking processes in problem solving. This includes constant monitoring of strategies used in carrying out a task, seeking alternative ways of performing a task and checking the appropriateness and reasonableness of answers.

At the primary level, concepts, skills and processes will be taught at a level appropriate to the cognitive development of the pupils. Attitudes and metacognition, though not given the same emphasis, form part of the teaching methodology.

The key features in the mathematics program include the development of concepts through meaningful activities, competence in basic skills including mental calculation, estimation and data handling skills, mathematical communication through oral work, group discussion and presentation of work done, investigative work and problem solving and mathematical thinking.

According to Barber (1998) there has been a change in recent thinking regarding numeracy in the early years and this has a bearing on what we need to provide in the early setting for mathematics. Emphasis has been put on achievement through practical

activities and on using and understanding language in the development of simple mathematical ideas. Current research indicates that traditional views on teaching numeracy based on Piagetian theory are doubted. The concept of conservation has had a great impact on the learning of mathematics for many years in the 60s and 70s. The teaching of numbers in the early childhood classroom was heavily dominated by activities such as matching, sorting and classifying.

Studies by Maclellan (1997) indicated that it is the counting skills approach and not the Piagetian logical operations approach which has led to higher skills of numeracy and there is little doubt that children's understanding of number is rooted in counting. Children need to count in many differing contexts to develop their skills and counting has to have a purpose to be made explicit for the children.

When children enter school, the links between home and the school mathematics are often hard to see and most teachers underestimate the knowledge that children bring along with them to school. Research by Munn (1997) shows that mathematics content is often inadequate and not so challenging in activities in early years setting. Vygotsky had emphasised the important role of adults and 'significant others' in the development of the child. His seminal work stresses on the impact of interaction, communication and instruction in the development of understanding. Following from that, subsequent researchers like Feuerstein and Hoffman (1985) has shown the interaction of mediated learning experience on the child's cognitive control.

In Singapore, one of the problems doing mathematics with young children is that the adults themselves are not very confident about the mathematics curriculum for pre-school children. Adults working with young children, parents included, need to be aware of the complexities associated with early mathematics learning and thinking, especially those connected with counting. Inservice programmes may help in this case . Another crucial role of adults is to help the young ones develop a positive attitude toward mathematics. They need to show how mathematics is used in our daily lives. In addition, children's ability and mathematical dispositions vary widely so we cannot generalise about the mathematics experience they need. Observing children in their play is a good way to start and every child has his or her own starting points and adults must value their individual differences.

To provide relevant activities in mathematics , various departments of mathematics in the Singapore schools spend a great deal of time in appropriate and relevant planning. It is based on children's previous experiences, on activities that are based in familiar contexts and mathematical language which is couched in everyday words used in a precise and particular way. To cope with the wide ranging activities of children in their young years, a number of activities have to be non-structured and flexible. Rhymes, songs, stories and games are all incorporated in a repetitive and interactive way in order that the rules of mathematical language be learned and appreciated in a familiar setting.

Hence, there are many issues to be considered when providing mathematical learning for young children and the Singapore experience has taught us that the early years setting is the most appropriate place to start as children move from home to school learning. We have gathered from recent research that the more abstract math gets, the more children will have conceptual and procedural problems. Many of these problems come from the traditional way math is being taught resulting in children doing a lot of meaningless computational work as they do not understand what they are doing. Parents and teachers have an important role to play to make clear the functions of mathematics and to set up a supportive context to create the mathematicians of the future.

Preschool Survey

A group of 25 preschool centers in Singapore were asked in a short survey the following questions:

1 How many hours of mathematics are taught in class in a week.
2 What kinds of math related activities are done in the center
3 Do parents get involved in their children's math learning
4 How do teachers make their maths lessons interesting
5 What is the type and frequency of interaction in a math class.

More than half of the total number of centers are ten or less than ten years old (14 centers) . Only 7 centers are more than 20 years old. The total number of children varies . 52% or 13 centers have 100-500 in enrolment; only three centers have above 500 and the rest (11 centers) have less than 100 in enrolment.

Question 1

Hours of maths per week	Number of centers
1 hour	1
2 hours	10
3 hours	6
4 hours	2
5 hours	5
6 hours	1

Question 2

Activities	Number of centers
Group work	25
Word problems	18
Games Music&Movement	25
Puzzles	20
Worksheets, Takehome	20

Question 3
18 centers indicated that their parents are very involved in their children's math learning. Activities include the following: homework assignment, number games, hands-on activities, assessment books, concrete materials, drill practices, games, puzzles, quizzes.

Question 4
Teachers make maths lessons interesting via :
Role play, hands-on experiences, games, manupilatives, cooking, art and craft, internet.

Question 5

Interaction in the classroom	Very frequent	Frequent	Seldom
Teacher-Child	13 centers	11 centers	1 center
Child-Child	14 centers	10 centers	1 center

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