Effectiveness of a mathematics program for 3 to 4 year children in urban Bangladesh

Aftab Opel*, Ferdousi Khanom*, Syeda Sazia Zaman*, Frances E. Aboud**

* Early Childhood Development Resource Centre, BRAC University Institute of Educational Development, Dhaka, Bangladesh.

** Department of Psychology, McGill University, Montreal, Canada.

Abstract

The purpose of the study was to examine the efficacy of a short-term mathematics program for 3 to 4 year children with the intention of increasing their math reasoning and skills. Six child development centers in a slum setting in Dhaka were randomly selected to be the Intervention group and 6 centers in a different slum setting for the Control group. Ten children were randomly selected from each center to participate in testing, though all participated in the program. A short program was adapted from an existing one, lesson plans created, and local materials developed. Teachers were trained and regularly supervised. Children in the control group participated in the regular program offered by an organization named Phulki. Children's math skills were tested before and after the intervention. An analysis of covariance on posttest scores, covarying pretest scores, child's age, sex, height for age, mother's education and family assets indicated that Intervention children doubled their scores while control children increased only slightly. The differences and effect sizes were highly significant.

Introduction

In view of the ongoing efforts to improve Early Childhood Development programs, this study evaluated a set of playful activities focusing on basic mathematical concepts for 3 and 4 years olds in early preschool centres in poor areas of Dhaka, Bangladesh.

Recently, a 6-week program of math activities was implemented in Plan Bangladesh preschools for 5-year-olds and evaluated in comparison with the regular program. The activities entailed concepts of numbers, shapes, patterns, measurement, sorting and comparing (adapted version of Llewellyn, 2004). They were less didactic than the regular program in that children were required to solve problems and check them. In an intervention-control pre-post design, children who had the math activity program made significantly greater gains in math skills than those in the regular program; the effect size was greater than 1.0 (Opel, Camellia, & Aboud, 2006). The results

indicate that with appropriate training, preschool teachers can implement an activity-based math program and children will benefit.

The objective of the present study is to translate and adapt a math program for younger children of 3-4 years and evaluate its effectiveness over short periods of time.

Ethical Considerations

Scientific and ethical approval of the protocol was provided by a review committee of academics and researchers in this field convened by BRAC University's Institute of Educational Development. Permission was obtained from the organization (Phulki) who implemented the early childhood programs, from the teachers who implemented the math activities, and from the mothers of children who contributed data to the evaluation. Data were kept confidential, names removed at the end, and outcomes did not have a bearing on the child's performance records.

Method

Design and sample size estimation

The design was a pre-post assessment of an intervention and control group. Using an alpha of .05 and power of .80, the sample size was 40 per group to find a difference of .75 SD (Standard Deviation based on prior studies was set at 7, and Mean of 20). To account for attrition, we initially enrolled 60. Therefore there were 6 learning centers per group with 10 children in each center.

Setting

Children were selected from 12 child development centers in two slum settings in Dhaka, Bangladesh. Out of 22 centers run by Phulki, six centers were randomly selected to be intervention centers and six to be controls. Phulki was established in 1991 and has been operating early childhood programs in Dhaka city since then. A few years back, it began using the materials provided by Plan International, an international child-focused NGO. In the usual two-hour daily program, there is no specific math curriculum or instruction. However, there are lots of materials available in the classroom that children can use for acquiring math concepts such as shape, number, and size. Consequently, the control children did not have math classes during or before the intervention. The intervention group got a daily math class of 25 minutes five days a week for six weeks.

The educational attainment of the teachers ranged from Grade 6 to 10. They received 4 days' training at the beginning of the year on basic knowledge for early childhood learning, child psychology, classroom management, etc. Monthly, they received 1-day training on how to implement the lesson plans for that month. Most teachers had been in this position for a reasonable length: intervention teachers had on average 3.8 years of experience with this age group, and the control teachers had 7.33 years.

Teachers received 300 *taka* or about US$ 4.5 per month as an honorarium provided by the organization. In addition, they also got 10-20 *taka* per child from the parents of

the children. This cost sharing was emphasized by Phulki to ensure community participation for long-term sustainability.

Participants

Ten students each from the 6 intervention and 6 control centers were randomly selected from a class list of 20-25 children to participate in this study. The remaining children attended classes as usual but were not tested. Of the 60 children enrolled for each group, 49 from the intervention group and 51 from the control group were available to take the posttest. Consequently data from 100 children were analyzed. Consent was taken from the parents of these children in order to collect data from them and their mothers.

Measures and testing procedure

Math skills. A test was created to assess the skills taught in the program, e.g. counting, patterns, shapes, measurement, comparing (Starkey et al., 2004). The test had 32 items and each was scored as correct or incorrect. An example of a test question was: *tester puts 4 coloured blocks on the table, along with number cards and ask the child to find the card that has the same number as there are blocks.* It took approximately 30-40 minutes to administer. Pre and post testing were conducted by research assistants, who interviewed each child individually on the math test in a quiet location near the center.

Socio-Demographic and Nutritional Status. The mother were interviewed before the intervention to collect information about the child's age, mother's and father's educational status, 11 family assets. The child's height was used as an indicator of nutritional status.

Eight female research assistants conducted the pre- and post-tests. All had prior extensive experience assessing children using different measures. They received a full-day training before the pretest and a half-day refresher training before the post-test on how to administer the tests in a child-friendly manner.

Intervention

The intervention was six weeks long implemented in September-November 2007, the seventh month of the academic year (there were breaks in the middle for Eid, an important Islamic religious event). An adapted version of selected activities from the Big Math for Little Kids – Prekindergarten version (Ginsburg et al., 2003) was implemented during the 25-minute math class five days a week. The activities required children individually and in groups to manipulate materials to arrive at solutions. Examples of the activities are provided below.

Counting and Enumeration. Counting different objects (1-10) to tell how many, comparing sets, number recognition, original number and position were taught in. Some examples are as follows:

- Teacher counts from 1 to 5, clapping as each number is said. Then all children do this together.
- Teacher puts five blocks in a row. After the blocks are set, the children count them. Teacher leaves the five blocks in a row but adds more space between each block. Children count them. Teacher asks if the number changes as the row gets longer.
- Teacher sits with a small basket in her lap where children cannot see into the dip. Teacher drops some blocks into the basket while children count silently to themselves as they see each drop. She asks, "How many blocks do I have in the basket?" Then they whisper their number to the teacher and she determines their accuracy.
- Teacher counts starting at one and stops, and then children have to say the number that comes next. Teacher counts starting at four and stops, and the children say what comes next.
- Teacher shows the card with the number 1. Children say 1. They put one block under the number. On another day, the teacher shows the cards 1 and 2. Children say 1 & 2. They put the corresponding number of blocks under each card. Teacher adds on a new number up to 5, placing the blocks in a column under the number.

Shapes. Identification of shapes with their properties, comparing shapes, making shapes from other shapes, shapes from home and nature were introduced. Activities include the following:

- The teacher puts many triangles and many rectangles in a make-shift cloth bag. She invites each child with eyes closed to find a triangle by feeling the foam pieces (not looking). Then she invites them to find a rectangle. To make it harder, the teacher puts multiple shapes in the bag, including hexagons.
- To make shapes from other shapes, teacher cuts a paper circle in two, a triangle cut through a side and another triangle cut through an angle, a square and a rectangle cut diagonally and vertically. Teacher lays all the circle and triangle pieces separately. Teacher says that each piece has a partner and together they make a shape. She shows how two circle pieces fit together and asks children, "What is the name of the shape?" Then she says that two pieces partner to form a triangle. She then asks children to find the two and then name the shape. Then each child put the pieces together and name the shape.
- To identify shapes from outside the classroom, teacher asks each child to bring to school an object in the shape of a circle or a rectangle or their 3-dimensions forms. A plate may represent a circle, a stick or pen may represent a line, a book is a rectangular prism, a ball is a sphere. If these things are not brought by children, she asks them find such objects in the class.

Patterns. Different activities allowed children to identify, create, copy, and extend sound, colour and shape patterns. For example, the teacher makes a pattern with two colours asks children to extend it (Red, Blue, Red, Blue, Red……). She makes a pattern of shapes (Circle ,Triangle, Square, Circle, Triangle, Square, Circle……..) and ask children to extend it.

Measurement. Concepts of measurement were taught by comparing the length of two or more objects, ordering objects by height and length, using comparative vocabulary such as same height, taller, and shorter,. The following are some activities:

- The teacher takes two blocks of different height, stands them side by side and asks children to tell which block is taller. She then makes two towers of different heights using two blocks and five blocks and asks which tower is shorter?
- To introduce the concept of comparing quantity teacher makes a pile of three blocks and a pile of two blocks of the same size. She then asks children to tell which pile has more or which pile has less? She then asks children to tell how can we make each pile have the same number of blocks? Teacher makes a pile of one big block and three small blocks and asks which pile has more blocks?

Materials: One of the principle factors guiding the choice of activities was the need to have low-cost and easily accessible materials. This intervention used materials such as number cards, shape cards, shape puzzle, story book on shape, wooden blocks and foam shapes.

Teacher training and supervision

Teachers of the 6 intervention centres received 15 hours of training on four different occasions, namely before each unit. A training manual was created describing different activities and games. Modifications were made to the manual during the training to incorporate the suggestions of the teachers.

On the job supervision was provided to the teachers during the 6-week implementation. Two trained supervisors visited them twice a week and help them get acquainted with this new teaching-learning procedure.

Method of analysis

T-tests were conducted on different demographic variables to determine if the random assignment of control and intervention yielded similar samples of children in the two groups. Post-test gains in the two groups were compared with an ANCOVA analysis, covarying baseline scores, child's age and height-for-age, mother's education and family assets.

Results

Characteristics of the sample

The table below shows that the children in the two groups were similar in socio-demographics variables. In terms of child age, mother's education and socioeconomic status (11 household assets) the two groups did not differ significantly. Control groups had non-significantly more girls and families had a bit higher income but the difference was non-significant between the two groups. Height-for-age was better in the intervention children.

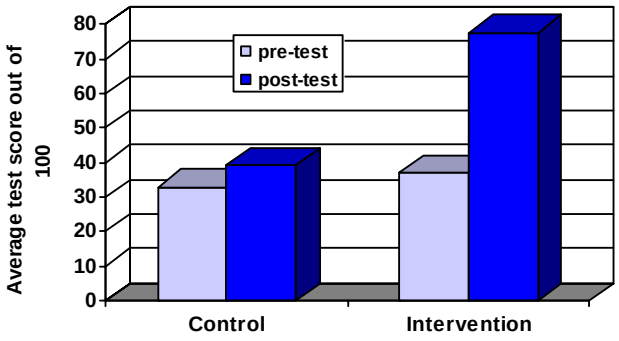
Table 1: Mean (SD) and t-values comparing control and intervention students.

Variable	Control (n = 60)	Intervention (n = 60)	t	p-value
Age (month)	54.57 (7.05)	52.72 (7.93)	1.35	ns
Mother education (yr.)	2.49 (2.74)	2.70 (2.79)	0.4	ns
Assets (11 assets)	5.47 (1.86)	5.94 (1.93)	1.31	ns
Income (month)	4533.9 (2084.06)	4033.3(1686.57)	1.39	ns
Height/Age z	-1.55	-0.97	2.58	.01
% Girls	67%	53%		ns

Math skills

The alpha coefficient for the 32 math items was .80. The pre- and post-test had 32 items that were scored either correct (1) or incorrect (0). Consequently, each child's score is the sum of points across all 32 items. The pretest and posttest scores, transformed into percentage correct, are presented in Figure 1. The posttest scores were subjected to an analysis of covariance, covarying first the pretest score, the child's age, height for age, mother's education, and family assets. The pretest covariate was significant ($p < .0001$), as expected. The posttest score yielded a significant effect for group, $F(1, 92) = 236.68$, $p < .0001$, partial $\eta^2 = .72$. The control students had pre and post means of 10.45 (SD 4.28) and 12.57 (SD 4.63), respectively, while the intervention students had pre and post means of 12.43 (SD 4.94) and 24.82 (SD 4.78), respectively. Adjusting for covariates, the effect size was d = 2.3. The improvement as a result of the math intervention was very strong.

Figure 1: Math score of control and intervention children



Discussion and implications

The evaluation strongly demonstrated that children at a very young age are capable of learning mathematics and of dealing with a challenging mathematics curriculum. Most 3-4-year-old preschools do not include any math activities other than what the children choose to do during free play. The on-going programs of this age group are heavily dominated by play, story telling and memorizing rhymes. This intervention also shows that para-professionals can implement such a sophisticated programme with systematic training and support. This intervention used very low-cost materials

which are essential for children to learn math concepts. It is therefore important to experiment with a full year math program to be able to include it in the curriculum.

It will be important to develop and evaluate a full year math program to be included in the curriculum. In the meantime, this short program should now be implemented in all SBK preschools to overcome the poor math skills of many young Bangladeshi children. Teaching children how to think about math will benefit them throughout school and in their daily lives.

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