Making Math Fun: A remedial Math intervention programme in Bengaluru's government schools

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Abstract: As India moves towards universalizing primary education, there are growing concerns about the quality of existing schools. An assessment of student outcomes in India has demonstrated that a large proportion of students in government schools is not at grade-level in basic reading or Mathematics. Past studies and scholarship have shown that a significant determinant of Math outcomes in primary schools is pedagogy. As a result, several initiatives have emerged in the past few decades to address the quality of schools and teachers around India. Akshara Foundation, a non-profit that works with government schools in and around Bengaluru, facilitates a numeracy-based remedial Mathematics programmeme to improve the learning outcomes of slow learners in standards 2-5. Results from the 2008-2009 data show that the programmeme was very successful in improving students' Math skills. Data also shows that on average, student learning levels increased by 20%, and the variance in learning outcomes decreased dramatically.

For the past century, developing countries around the world have been striving to universalize primary education. The Declaration of Rights of Child, Jomtien, Cairo, and Dakar, EFA Global Monitoring Reports, national constitutions and pledges among civic action groups have all repeatedly asserted the importance of achieving universal primary education, and there have been significant gains in recent years. According to World Bank statistics, while India's net primary enrolment rates increased by merely 2% from 1990 to 2000, it increased by 10% from 2000 to 2007.[1] However, while the number of primary schools continues to grow, the quality of existing schools remains poor. The quality of schools in India has implications for attendance

[1] EdStats. The World Bank: Country Profiles, Education Trends and Comparisons. <http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTEDUCATION/EXTDATASTATISTICS/EXTEDSTATS/0,,contentMDK:21605891~menuPK:3409559~pagePK:64168445~piPK:64168309~theSitePK:3232764,00.html >

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rates, attrition rates, a child's contribution to the economy[2] and even a child's ability to participate fully in a democratic society.[3]

It is difficult to compare the quality of India's government schools to schools in other countries because India has declined to participate in the two major international assessments, TIMSS and PISA. However, UNESCO published a report in 2005 that compared the quality of primary schools around the world in more general terms. The report indexes the quality of schools according to four categories: net enrolment rate, literacy rate of people aged 15 and over, gender parity[4], and survival rate to std. 5. Out of the 127 countries included in the study, India ranked 106th with a score of 69.6%.

Within India, ASER publishes an annual report card of the status of education outcomes in government schools. According to the 2008 survey,[5] out of the approximately 74% of students in government schools in stds. 3-5, only 27.9% of Indian students and 24.2% of Karnataka students in std. 3 are able to do subtraction and only 10.8% of Indian students and 3.3% of Karnataka students are able to do subtraction and division. In std. 5, 37% of Indian students and 16.9% of Karnataka students are able to do subtraction and division. NCERT carried out a study in 2006 as well, and the average percentage marks for India were lowest for Math at 46.5%, 50.3% for Science and 58.6% for Language.[6]

Apart from socio-economic status, scholarship has consistently shown that teacher quality is the primary determinant of student outcomes. A 1983 study by Heyneman and Loxley found that 27% of the variation in student performance is determined by teacher quality, which is a higher proportion than in any other country they surveyed.[7] Wu et al completed a study on Mathematics achievement in primary schools in 2009 and they similarly found that "teachers play a crucial role in student performance." Holding school effects and SES constant, they found that teacher training on subject matter and pedagogy have the highest correlation with student

[2] Fuller,Bruce and Stephen P. Heyneman. "Third World School Quality Current Collapse, Future Potential." *Educational Researcher*. Vol. 18, No. 2 (Mar., 1989), Page 14.
[3] Sen, Amartya. Development As Freedom. London: Oxford University Press. 1999. Page 39.
[4] The gender-specific EFA index takes the primary and secondary enrolment rate ratios and the adult literacy rate.
[5] Assessment Survey Evaluation Research Centre. All India ASER 2008.
< http://www.asercentre.org/asersurvey/aser08/data/in/in-enr-08.php>
[6] National Council of Educational Research and Training. Educational Survey, 2006.
< http://www.ncert.nic.in/html/educationalsurvay.htm>
[7] Heyneman, Stephen and Loxley, William. "The Effect of Primary-School Quality on Academic Achievement Across Twenty-nine High- and Low-Income Countries" *The American Journal of Sociology*. The University of Chicago Press, 1983. Page 1174.

outcomes.[8] In order to improve math outcomes among students in government schools, teaching tools and teaching methods must be improved.

The dire condition of math learning in government schools has prompted several initiatives to improve pedagogy and learning materials. Education-related NGOs that are able to reach a significant amount of children "do not aspire to be parallel providers of primary education, but wish to act as catalytic forces to improve the effectiveness of the Government system," said Shanti Jagannathan in her analysis of NGO activity in Indian education.[9] There are several NGO initiatives in Karnataka. Nali Kali, a Karnataka government programme, uses Montessori-style pedagogy to cater to students of different learning levels and employs activity-based learning. Similarly, the Akansha Foundation has designed "General Awareness Level" math programmes to bring students up to grade-level math. Based out of Chennai, Eureka works to make primary level mathematics relevant to students' everyday lives. In addition, the Karnataka Learning Partnership website lists 83 NGO partners, all of whom are working to improve primary education.

Akshara, the facilitator of the Karnataka Learning Partnership, has three main intervention programmes in primary schools: a reading programme, a library programme and a math programme. The remedial math programme, Nagu Nagutha Ganitha (NNG), was launched in 2007. As the ASER report card indicates, a significant proportion of students are not at grade level in math and the proportion that falls below grade-level proficiency increases as students progress through school.[10] NNG works with slow-learners in stds. 2-5 to bring students up to grade level proficiency. The programme is designed to cement foundational mathematics. Equipped with a mathematical language, students are enabled to access more abstract concepts and lessons.

NNG was designed by Dr. T. Padmini, a Professor of Education, Emeritus, at the University of Mysore. Nagu Nagutha Ganitha was tried and tested in government primary

[8] Wu, Kin Bing, Goldschmidt, Pete, Boscardin, Christy Kim and Sankar, Deepa(2009) 'International benchmarking and determinants of mathematics achievement in two Indian states', Education Economics, 17: 3, 395 — 411. Page 407.

[9] Jagannathan, Shanti, The Role of Nongovernmental Organizations in Primary Education: A Study of Six NGOs in India (November 2000). World Bank Policy Research Working Paper No. 2530. Available at SSRN: http://ssrn.com/abstract=632600

[10] Kingdon, Geeta Gandhi. "The progress of school education in India." Oxford Review of Economic Policy Volume 23, Number 2 Pp. 168-195.

schools in Mysore by Pratham Mysore. The NNG model is tailored for classrooms with multiple learning levels. It is open-ended, allowing freedom for imagination and creativity. The child here studies at his or her own pace and there is sufficient room for learning hands-on with the given material through games, puzzles and activities. At the same time, NNG does not in any way deviate from the school curriculum. The only difference is that concepts are taught using concrete tools like a counting board and number grids, helping children see, do, learn, and hence, comprehend mathematics, rather than the conventional blackboard method. NNG's success signals a shift from convention while remaining well within the purview of the school syllabus. The programme allows a child to leverage her natural creativity and curiosity to explore different ways to arrive at a solution.

Nagu Nagutha Ganitha, or "joy of mathematics," aims to teach elementary students numeracy in an engaging way. Numeracy can be defined as the mathematical skills that "enable an individual to cope with everyday life."[11] Essentially, it is the ability to reason mathematically – to relate symbols to ideas, from concrete math functions to abstract concepts. Therefore, NNG does not merely aim to teach children to add and subtract, but also teaches them how to apply addition and subtraction to both real world and abstract situations.

NNG is also characterized by student-centreed learning. Central to this conception of pedagogy is the promotion of active knowledge acquisition through exploration, discovery and reflection rather than passive absorption of facts and skills through rote memorization. Students learn that there is more than one way to solve the same problem. Instead of solely absorbing knowledge by listening to the teacher enumerate mathematical principles, students actually 'discover' principles by working with materials and, eventually, perceiving the more abstract ideas. In student-centreed programmes, students are able to learn at their own pace.[12] This is especially helpful in a classroom with multiple learning levels.

Activity-based math education is widely accepted among educationalists as the active "involvement of students in the process of learning mathematics."[13] The understanding of

[11] Cockcroft, Wilfred H. *Mathematics Counts.* London: Her Majesty's Stationery Office. 1986.
[12] Nykiel-Herbert, Barbara. "Mis-Constructing Knowledge: The Case of Learner-Centreed Pedagogy in South Africa." *Prospects*, vol. XXXIV, no. 3, September 2004.
[13] Suydam, Marilyn N. and Jon L. Higgins. "Activity-Based Learning in Elementary School Mathematics: Recommendations From Research." *Information Resource Centre (ERIC/IRC).* Columbus, Ohio: The Ohio State University. 1977.

"concrete" to "abstract" is well understood in education theory and practice.[14] The toolkit designed by Dr. Padmini contains materials for activity-based learning. For several decades, research has similarly corroborated that teaching with material aids not only improves student outcomes, but also student attitudes towards learning.[15]

Ultimately, NNG can only be as successful as the teachers are in implementing it, since government school teachers are the final conduits of the programme. Arbaugh and Brown assert that there is a two-way relationship between teacher beliefs and practices - if teachers witness the success of certain pedagogical methods in terms of student outcomes, they will be more likely to subscribe to that method of teaching.[16] Teachers undergo a one-day training to familiarize themselves with the NNG workbooks and learning materials. However, they may only be convinced of NNG's effectiveness after their students have been through the 60-day programme and have improved their numeracy skills.

Finally, NNG is characterized by its strong commitment to joyful learning. Among the six principles of practice for effective teaching of numeracy that Muir identifies in her analysis of teaching numeracy, she includes the importance of positive attitudes towards math-learning. [17]

NNG consists of four competencies:

1. Numeracy (C1) – Number concepts and place value
2. Four Operations (C2) – Addition, subtraction, multiplication, and division
3. Quantitative Reasoning (C3) – Shapes, money, calendar, time
4. Mental Math (C4) – Problem-solving without written calculations

These foundational skills were found to be prerequisites for moving to higher levels of math. Children from stds. 2 and 3 form Level 1 and children from stds. 4 and 5 comprise Level 2. NNG

[14] Clements, Douglas. "Concrete Manipulatives, Concrete Ideas." *Contemporary Issues in Early Childhood*, Vol. 1, No. 1, 1999
[15] Sowell, Evelyn J. "Effects of Manipulative Materials in Mathematics Instruction." *Journal for Research in Mathematics Education*. Vol. 20, No. 5, Nov. 1989.
[16] Arbaugh, F., & Brown, C. A. (2005). Analyzing mathematical tasks: A catalyst for change? *Journal of Mathematics Teacher Education, 8*, 499-536. Page 4.
[17] Muir, Tracey. "Principles of Practice and Teacher Actions: Influences on Effective Teaching of Numeracy." *Mathematics Education Research Journal*. Vol. 20, No. s, pg. 78-101. 2008.

begins with a foundation of number concepts and progresses gradually, covering the four basic operations of Mathematics and going up to fractions and decimals for Level 2 children.[18]

The assessment was designed as a diagnostic test and covers a narrow range of competencies that are considered essential to learning higher order concepts. It is not a general 'achievement' test that mainly appraises the overall performance of the whole class covering a wide range of content. Diagnostic testing analyses the problems and deficiencies in students' learning, which, in turn, helps the teacher to choose the appropriate content and thinking strategies to address in the remedial programme.

Students in stds. 2-5 who were enrolled in Pariharabhodane went through an initial diagnostic test. A similar test on the four competencies was given at the end of 60 sessions ('post-test') to measure the impact of NNG on student learning. The test included questions on each of the four programme competencies. The tests on Numeracy and Four Operations are paper and pencil tests, while the tests on Quantitative Reasoning and Mental Math are aural tests, wherein the teacher reads out the question and the children listen, comprehend and write the answer in the given paper. As indicated earlier, students were graded on a class-specific scale to match the expected grade-level competency of each child. Please see Appendix for the exact assessment marks.

For std. 3, 4, and 5 children, the post-test covered the same competencies as the pre-test, but in a more comprehensive manner. Percentage scores for each child were calculated from the raw scores, and students were divided into quintiles. Rung 1 represents children scoring below 20%, Rung 2 represents children scoring between 20% and 40%, and so on. A similar percentage score and rung is calculated for each individual competency. For example, a child can be in Rung 5 for Numeracy and Rung 1 for Mental Math, with a composite score in Rung 4. For each child, there is also a "jump in rungs" – the number of rungs the child has moved (if any). For example, a child who began at Rung 1 on the pre-test and moved to Rung 3 on the post-test day has "jumped" two rungs.

There are a few obvious limitations to NNG. Firstly, Akshara did not have control over the selection of students who participated in the programme. Because slow-learning students were selected by teachers and not by Akshara staff, it is possible that teachers' conceptions of

[18] For a full discussion about the materials used in NNG, see the Appendix.

what exactly constitutes a slow-learner inevitably vary. However, in the analysis below, we look at both absolute gain scores (differences in pre- and post-test scores) and our analysis is primarily comparative. Secondly, teachers implemented the programme in vastly different ways making it difficult to hold pedagogy constant across different classes and schools. Much of this variation was due to time issues. Additionally, some teachers chose to focus more on math games, while others focused more on workbook exercises. Finally, attendance rates varied widely among different students. If a student missed a particular lesson, it could have appeared in their post-test assessment. Their scores on the final assessment may have been due to their absence rather than their responsiveness to NNG. With these confounding factors in mind, the analysis below discusses the effectiveness of NNG as accurately as possible.

In January 2007, a short 30-day pilot in select schools in Bengaluru South and North was conducted to test the effectiveness of the programme locally before rolling out the programme across Bengaluru South. In 2007 the programme was rolled out in all the schools at South blocks and Anekal in which 35,768 children were part of the programme. In the 2008-2009 academic cycle, the programme was implemented in all schools of Bengaluru North district in conjunction with Parihara Bhodane. NNG sessions were taught in small groups; under 20 children were assigned to each teacher in the programme. The analysis below reflects the data from NNG 2008-2009. In 2008, students were divided into groups of 15-20 students and each school had between 1 and 16 groups. [19] Students were assessed on a class-wise scale such that the total available marks varied according to grade and skill level.

Table 1 depicts the percentage of participation in NNG according to area and class. A total of 91%, or 4 out of the 9 educational blocks participated in NNG. 1,029 centres were established, each with 15-20 students. Because teachers know their students' needs best, they selected students who were in need of remedial mathematics to participate in NNG. As a result, there were 18,413 children identified as eligible for entering the NNG programme in 2008-2009. Of the total, 2% of students were not present for pre-testing and 11% were not present for post-testing, totaling 2,198 students. Additionally, there was a data error in 257 test papers. In this

[19] GUMPS Goagarden school of DJ Halli cluster recorded highest number of centres.

analysis, only those children who properly completed both the pre-test and the post-test are considered (N=16,161).

Table 1. Participation in NNG

	Bengaluru*	**Bengaluru North Total**	**Bengaluru North Participating**	
Schools	1,412	509	467	91%
Std. 2	29,985	14,096	4,679	33%
Std. 3	30,372	14,158	4,617	33%
Std. 4	34,808	16,463	4,674	28%
Std. 5	32,245	15,089	4,443	29%
Total	1,27,410	60,357	18,413	31%

The largest proportion of students enrolled in NNG, 41%, came from North-4, as noted in Figure 1. North-2 had about 25% of students in NNG. North 2 and 3 contained an even smaller proportion of students. Figure two depicts the participation in NNG by class. Each class comprised around one-fourth of the total participation in NNG. The data shows that nearly 90% of the children enrolled in NNG completed both assessments. The analysis shows that there was a positive response to the programme and the completion rate was almost 90%. This remains more or less consistent across different blocks and classes.

Figure 1. Participation by Block

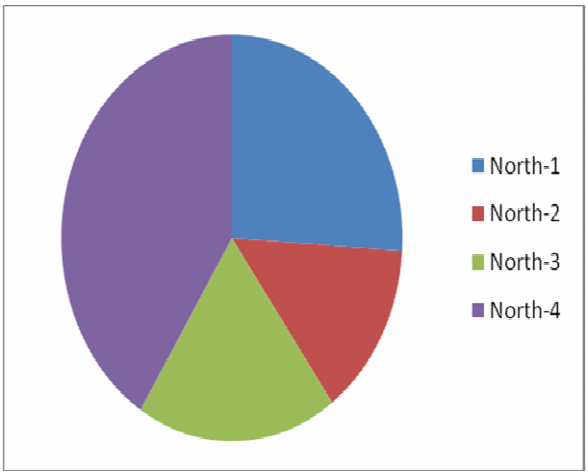
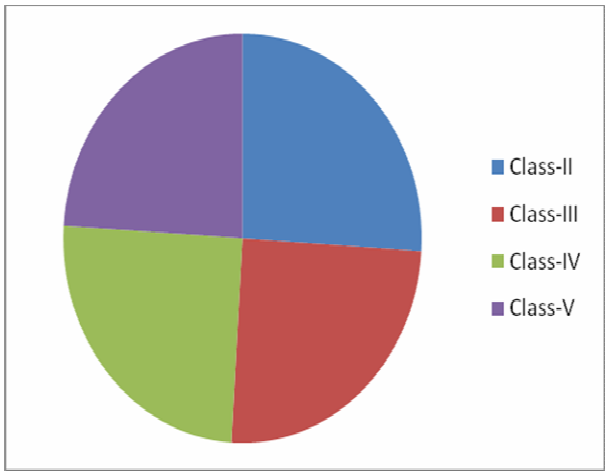
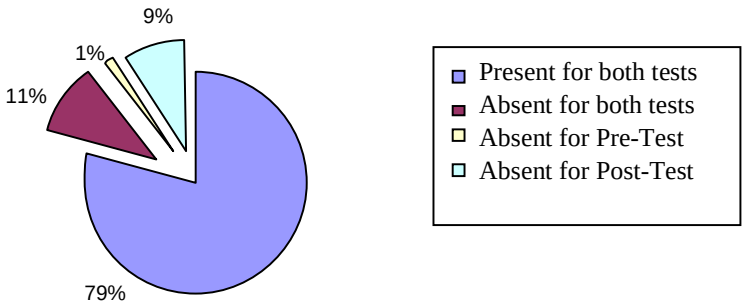


Figure 2. Participation by Class



79% of the children were present for the pre- and post-test. 1% of children were absent on the pre-test day, 9% were absent for the post-test and 11% were absent for both tests. Only students present for both tests are considered for the study.

Figure 3. Absenteeism



Results

At the completion of the programme, there was an average increase in scores of 21 percentage points. Accordingly, the number of children in Rungs 1, 2, and 3 came down and the number of children in Rungs 4 and 5 rose. The average score on the pre-test among all classes was in the 60th percentile, but in the post-test the average score in all classes rose to the 80th percentile. Additionally, and rather astonishingly, less than 1% of students remained in Rung 1 in the post-test and only 1% of students in each class were in Rung 2 in the post-test. The standard deviation among all the classes also decreased, signifying that there was less variance in student test scores on the post-test.

Table 2. Results by Class

	Pre-Test					Post-Test				
	Std. 2	Std. 3	Std. 4	Std. 5	All	Std. 2	Std. 3	Std. 4	Std. 5	All
Mean Score (Std. Dev.)	63.8 (23.5)	61.1 (22.4)	62.8 (21.8)	65.6 (22.2)	63.3 (22.5)	85.4 (13.7)	82.4 (15.2)	83.2 (14.4)	84.6 (13.4)	83.9 (14.2)
0%	1%	0.10%	0.26%	0.37%	0.39%		0.05%	0.05%	0.03%	0.03%
Rung 1	5%	5%	4%	4%	4%	0.15%	0.18%	0.17%	0.08%	0.14%
Rung 2	12%	15%	14%	12%	13%	1%	1%	1%	1%	1%
Rung 3	24%	27%	24%	21%	24%	5%	8%	6%	6%	6%
Rung 4	30%	32%	35%	34%	33%	20%	27%	26%	23%	24%
Rung 5	28%	22%	24%	30%	26%	73%	63%	66%	70%	68%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

It is worrying that some students like Banu of GUMPs NS Lane and Siddiqa A of GULPS Modi Road were unable to score higher than 0% even on the post-test. The NNG strategy is clearly not working among these students, although the test scores do serve as a warning indicator of poor achievement. These students may have learning disabilities or other issues that need to be addressed.

As can be seen in Table 3, the largest movement was into Rung 5 and out of Rungs 3 and 4. Rungs 1-4 all had negative changes as more students moved out of the rung than into it. As can be seen from the table, most of these students moved into Rung 4.

Table 3. Class-Wise Differences in Pre- and Post-Test Scores					
	Std. 2	Std. 3	Std. 4	Std. 5	All
0%	-1%	0.05%	0.31%	0.36%	0.36%
Rung 1	-5%	-5%	-3%	-4%	-4%
Rung 2	-11%	-13%	-10%	-12%	-12%
Rung 3	-19%	-19%	-14%	-18%	-18%
Rung 4	-10%	-5%	-8%	-9%	-8%
Rung 5	45%	42%	36%	44%	42%

The few students who scored 0% on the pre-test in std. 2 improved their scores. From these two tables, the improvement in student achievement is dramatic. Overall, NNG 2008-2009 seems to have had a significant effect on student achievement across all classes.

Block-wise analysis of the data shows similar consistency in improvement, with a few variances. Students in North-1 generally scored better than other students on the pre- and post-test. This block had significantly more students in Rung 5 than any of the other blocks.

Table 4. Results by Block								
	Pre-Test				Post-Test			
	NORTH-1	NORTH-2	NORTH-3	NORTH-4	NORTH-1	NORTH-2	NORTH-3	NORTH-4
Mean Score (Std. Dev.)	63% (23.1)	56% (21.7)	60% (23.4)	67% (21.1)	87% (12.5)	83% (14.3)	82% (14.7)	83% (14.7)
0%	0.22%	0.61%	0.80%	0.24%	0.02%		0.06%	0.03%
Rung 1	5%	6%	5%	3%	0.02%	0.19%	0.25%	0.15%
Rung 2	14%	16%	16%	10%	1%	1%	1%	1%
Rung 3	25%	32%	24%	21%	4%	7%	8%	7%
Rung 4	30%	32%	33%	35%	18%	28%	28%	25%
Rung 5	26%	13%	21%	31%	77%	64%	63%	66%

Similar to the class-wise analysis, most students moved out of Rungs 1 and 2 and most students moved into Rungs 4 and 5.

Table 4 corroborates a Block-wise analysis of scores. There does not seem to be a significant variation in scores across the different blocks. Although North-2 scored lower than

the other blocks on the pre-test, it also gained more than the other bocks and had an average post-test score that is higher than that of North-3.

Table 5. Results by Block

	Pre-Test	Post-Test	Difference
NORTH-1	62.6	86.8	24.2
NORTH-2	56.5	82.5	26.0
NORTH-3	60.2	82.2	22.0
NORTH-4	67.4	83.3	15.9

Students in North-4, who scored significantly higher on average, did not improve as much as the other Blocks.

In table 9, results are depicted according to math competencies. The table shows that the largest gains were in competencies 2-4. Competency 1, focusing on basic numeracy, had the smallest gains. However, students also started at higher competency levels (on average, 76%) than

Table 6. Results by Competency

	Pre-Test	Post-Test	Difference
Numeracy (C1)	76%	89%	13%
Four Operations (C2)	56%	81%	25%
Quantitative Reasoning (C3)	61%	84%	23%
Mental Math (C4)	63%	83%	20%

in other competencies and therefore the final average competency in numeracy was actually the highest. In the other competencies students improved more than 20%.

Gender-wise distribution of scores shows that there were minor differences among boys and girls. As is shown in Table 7, both achieved similar percentages on the pre- and post-tests, and their gain scores were similar as well.

Table 7. Results by Medium of Instruction			
	Pre-Test	Post-Test	Difference
Girls	64%	84%	10%
Boys	63%	84%	11%

We were also able to look at the average scores of students according to the medium of instruction. Because Akshara provided NNG materials in Urdu, Kannada, Tamil and Telugu, the assessments were also in these languages. There was only one Tamil-medium school and one Telugu-medium school that participated in NNG, with 15 students in the Tamil-medium school and 45 students in the Telugu-medium school compared to 13,491 students in Kannada-medium schools and 2,726 students in Urdu-medium schools. Therefore, the results from these student assessments are not as statistically powerful. The table below shows that there was wide variation in the pre-test scores among Kannada-medium and Urdu-medium schools.

Table 8. Results by Medium of Instruction			
	Pre-Test	Post-Test	Difference
Kannada	61%	84%	23%
Tamil	56%	66%	10%
Telugu	56%	85%	24%
Urdu	78%	86%	8%

Students in Urdu-medium schools scored 17% higher, on average, than students in Kannada medium schools. However, the gain score among students in Kannada schools was much higher, and by the post-test these students were only 2% behind students in Urdu-medium schools.

In Table 9, the results are displayed according to the language children speak at home. The variation among Kannada-speakers and Urdu-speakers is small, both on pre-test and post-test assessments. However, Tamil speakers (1,080) and Telagu speakers (1,030) had significantly

lower pre- and post-test scores. Almost all Tamil and Telugu-speaking children are in primary schools where the medium of instruction differs from their mother tongue, which could explain their low achievement.

Table 9. Results by Medium of Instruction

	Pre-Test	Post-Test	Difference
Kannada	64%	84%	20%
Tamil	67%	77%	10%
Telugu	39%	60%	21%
Urdu	60%	80%	20%

This is especially important given that students in the Telugu medium school had extraordinarily high gains, 24%, from the pre- to post-test. Students who attend a school in a medium of instruction different from their mother tongue seem to be learning less at the primary level.

Summary

To improve the quality of government schools in Bengaluru, Akshara has implemented a numeracy-based remedial mathematics programme. The programme was designed to enable children of multiple learning levels to study math creatively, and at their own pace. The pedagogy focuses on activity-based tasks and Akshara provided schools with several learning materials and trained teachers on effective pedagogy for basic remedial math. The results from 2008 depict large gains in student learning. On average, students scored 20% higher on the post-test than they did on the pre-test. This was true across class, gender, block, and medium of instruction.[20] However students from Tamil- and Telugu-speaking families who attended schools with a different medium of instruction recorded lower gains and outcomes compared to Kannada- and Urdu-speaking students.

[20] We except Tamil and Telugu since the programme only happened in one school of each language, and therefore the results are not statistically powerful.

Appendix 1 –Total Marks Assigned

Table 1. Assessment Total Marks

	C1	C2	C3	C4	All
Std. 2	16	24	10	10	60
Std. 3	20	30	10	10	70
Std. 4	25	30	10	10	75
Std. 5	25	30	10	10	75

Appendix 2 –NNG Kit

NNG employs several materials to help students develop their numeracy skills. The math kit, a set of teaching/learning materials provided to teachers as part of the NNG curriculum, is designed to help children link the concrete to the abstract. The math kit contains three main teaching tools – the Concrete Counting Board, the Number Grids and the Padmini Counting Board. The Concrete Counting Board consists of counting beads and is intended to help children develop up to five-digit numeracy skills. The Number Grids help children link number concepts with written numbers. A variety of number grids provide identification of number gradation, number patterns, etc. A number grid used as an aid or a reference card to perform different arithmetical tasks helps children to develop representational thinking by absorbing into visual memory the number patterns made available in the grid. Finally, the Padmini Counting Board uses a series of mathematical games and puzzles and interactive sessions to enable students to solve the mathematical problems of daily life exercises oral and practice their mental arithmetic skills. The Padmini Counting Board is central to the NNG curriculum and has received wide acclaim from teachers. The counting board borrows richly from an ancient game, the age-old pallanguzhi or pallankuli or Alaguni Mane, played in South India, especially in Tamil Nadu and Andhra Pradesh. The Padmini Counting Board consists of four plastic strips and a set of place value counting chips representing units, tens, hundreds, thousands and ten thousands. The plastic chip for each place value has been designed in a different colour and shape.

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