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- **THE MAKING OF LITTLE MATHEMATICIANS:**
- **FOSTERING EARLY MATH**
- **UNDERSTANDING IN PARAGUAY**

Summary: That four- and five-year-olds can do algebra, arithmetic, and geometry may be hard to believe. But if you visit a preschool classroom in the Cordillera region of Paraguay, you will see children who learn factoring by organizing balls and sticks into groups, and who work together to form pentagons and hexagons with their bodies. These children are participating in a project called “Tikichuela, Mathematics in My School,” the result of a partnership between the Japanese and Paraguayan governments, the Organization of Ibero-American States (OEI), and the Inter-American Development Bank (IDB). The idea behind the curriculum is that preschool children need to learn premath skills to build a foundation for primary- and secondary-level mathematics. Assessed after five months, the math skills of children in the program had increased significantly compared with those of a group of children not in the program. This brief describes the implementation of the pilot program and its qualitative and quantitative findings.

Before Tikichuela: Poor premath skills among students and teachers alike

Baseline tests showed that preschool children in Cordillera had poor math skills. The average child could name only two out of four geometric shapes and was unable to recognize four numerals. These deficiencies made it harder for children to succeed in mathematics at the primary level, because they didn’t understand the basic concepts upon which future learning must build.

Baseline tests also revealed that preschool teachers felt unprepared to teach math; 94 percent stated that they had difficulties structuring their math lessons, 90 percent that they were unable to teach all topics in the preschool mathematics curriculum. Additionally, 40 percent of teachers reported giving math lessons three days or fewer per week, rather than daily as stipulated in the curriculum. These baseline findings suggested that teachers needed support in consistently implementing and completing math lessons.

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Transforming teaching

The Tikichuela methodology helps children develop positive long-term attitudes toward math and premath skills that help them excel in school and the rest of life. It is inspired by an American mathematics program called “Big Math for Little Kids,” developed by professors from Boston, Columbia, and Johns Hopkins universities. To bridge the knowledge and pedagogical gaps of teachers, Tikichuela’s interactive program uses audio CDs to teach standardized lessons, decreasing the burden on teachers and helping them complete the preschool math curriculum. The lessons are delivered in both Spanish and Guaraní, because many of the children are bilingual or speak a mix of the two languages. Teachers receive training and in-class tutoring in the interactive audio methodology.

Evaluating Tikichuela

A rigorous evaluation assessed whether the new curriculum brought gains in math scores. The program studied almost 3,000 students across 265 schools. Since the pilot did not have enough funding to be applied in all schools in the district, the evaluation made the most of the circumstances by randomly assigning 131 schools to the Tikichuela program and the remaining schools to the control group.

The program encompassed rural and urban areas, different school types, teachers of different skill levels, and children who spoke different languages. Several subgroups of the population were studied, and while improvement was seen across a wide range of the sample, factors such as student gender and school type were found to influence the degree of improvement. The evaluation included both qualitative and quantitative measures of teachers’ perceptions of the impact of the program, as well as surveys of parents and guardians to determine their key characteristics (including their primary language and level of education).



Closing achievement gaps

After only five months, students in the pilot program saw, on average, a 16-point increase in scores (almost a fifth of a standard deviation) over those not in the program. In percentage terms, this means that the program produced a 9.2 percent increase in math learning. The achievement gap between low- and average-performing students (those in the bottom third) and high performers (in the top third) decreased by 7.5 percent. In other words, the program was able to target those needing the most remedial work in mathematics.

Encouragingly, both boys and girls saw significant increases in their math scores. But boys across the sample did better than girls, suggesting that a combination of cultural factors and gender differences affected the results of the program. Notably, Tikichuela girls not only caught up with boys in the control group, but surpassed them despite initially lower scores.

The program helped close the learning gap between advantaged and disadvantaged schools.

Peripheral schools, which typically enjoy fewer resources than those at the center of school networks, saw a significant improvement in scores—21 points higher, on average, than peripheral schools not in the program. As a result, the mathematics learning gap between the two groups of schools decreased by 44 percent.

The program improved math scores for both Guaraní- and Spanish-speaking students, with bilingual children showing the most improvement. This provides evidence that the design of the pilot program, in which lessons are first taught in Spanish and then repeated in Guaraní, was effective. The repetition may help to explain why bilingual children performed the best—they, effectively, received the lesson twice.

Tikichuela works in multigrade classrooms. Preschoolers placed in multigrade classrooms, or those in classes with children of various ages and skill levels, experienced the same level of improvement in their math scores as preschool children in more homogenous classrooms. These results are important given the reality of the education system in Paraguay, where multigrade classrooms are common and typically have lower achievement levels than classrooms with only one grade level.

Tikichuela closes the experience gap among teachers. Preschoolers who had teachers who lacked specific training in early education or had had only one specialized course in the subject saw a greater improvement in scores than children whose teachers specialized in preschool education. These findings suggest that Tikichuela helped close the experience gap between highly trained teachers and those without specialized preschool training.

Table: Tikichuela’s Impact

Dependent variable	Mathematics	
	Test score gain due to Tikichuela (%)	Impact of Tikichuela (SD)
A. Global effects		
Impact	9.2	0.16*** (0.03)
B. Placement in pre-test (within schools)		
In group with lowest scores	12.1	0.19*** (0.04)
In group with middle scores	10.3	0.19*** (0.04)
In group with highest scores	5.2	0.11* (0.05)
C. Effect by gender		
Boys	12.3	0.21*** (0.04)
Girls	6.3	0.13** (0.03)

Standard errors are in parentheses.

* significant at 10%; ** significant at 5%; *** significant at 1%

Recommendations and next steps

The Tikichuela students will be observed over the next few years to see if their achievement gains translate into sustained improvements in the math skills of previously underperforming students.

To close the gender gap, the program is being modified to encourage increased participation and interest in mathematics among girls. Tests will demonstrate whether a redesigned audio program—which specifically invites girls to do math—translates into learning gains.

The success of the preschool pilot has also led to the decision to expand the program to the first grade at the beginning of the 2013 school year.

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