



جائزة خليفة التربوية
Khalifa Award for Education



Khalifa International Award for Early Learning Inter – American Development Bank (IDB)

Abstract

JADENKÄ is an intercultural bilingual education model to enhance the mathematics learning of indigenous preschool students. The program uses an innovative audio methodology to address the challenge of classrooms with indigenous students throughout Latin America and the Caribbean that lack teachers with the indigenous language and cultural knowledge required to provide quality intercultural bilingual education. JADENKÄ uses inquiry, music, and structured play to teach foundational skills. An experimental evaluation in Ngäbe-Buglé, a comarca in Panama, showed an impact on mathematics learning, ranging from 0.12 to 0.18 standard deviations, and a positive influence on students' cultural identity. Additionally, teachers in the treatment group deepened their understanding of the Ngäbere language and culture. JADENKÄ was a collaboration among the Organization of Iberoamerican States (OEI), the Ministry of Education of Panama (MEDUCA), Innovations for Poverty Action (IPA), and the Inter-American Development Bank (IDB) with generous funding from the Government of Japan.



JADENKÄ: Intercultural Bilingual Early Childhood Mathematics Education in Panama

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Indigenous children across Latin America and the Caribbean (LAC) face significant disparities in accessing education and acquiring knowledge. These disparities become evident as early as the pre-primary education stage (Näslund-Hadley & Santos, 2022).

A major obstacle to the learning process among young indigenous learners is the use of the majority language instead of their native language as the medium of instruction. This challenge is compounded by the absence of "contextualization" in the curriculum, lesson plans, and educational materials, which fail to incorporate indigenous cultures into a holistic approach for the youngest students (Rodríguez Gómez and Harris-Van Keuren 2012; Araujo, López-Boo, and Puyana 2013).

Additionally, teachers assigned to educate indigenous students often lack proficiency in their native languages (Näslund-Hadley & Santos, 2022).

Innovation

JADENKÄ (pronounced “ha-den-go”) is the world's first randomized experiment in bilingual and intercultural mathematics education designed for indigenous preschool students. This pioneering program employs an innovative audio-based methodology to address the challenges faced by classrooms serving indigenous students throughout Latin America and the Caribbean.

JADENKÄ is an intercultural bilingual educational approach tailored for four to five-year-old children. It utilizes inquiry-based learning, problem-solving, music, and structured play to teach fundamental mathematical skills that form the foundation for primary school mathematics, including concepts like number sequences, object counting, and spatial orientation. In Latin America and the Caribbean, comprehensive preschool mathematics programs are a rarity in themselves. What distinguishes JADENKÄ is its integration of both Spanish and the children's native language, Ngäbere, while blending Western mathematical principles with intercultural or ethno-mathematics. The program's development involved a multidisciplinary team of experts well-versed in pedagogy, interactive radio instruction methodology, Ngäbe culture, and early education. Collaboratively, the Organization of Iberoamerican States (OEI), the Inter-American Development Bank (IDB), and the Ministry of Education (MEDUCA) developed the program, aligning it with international early mathematics education curricula while harmonizing it with the national preschool curriculum and educational objectives.

Throughout the development of the JADENKÄ program, consultations were held with elders from the comarca to gather input on the program's learning objectives, concepts, skills, and activities. These consultations played a pivotal role in gaining acceptance for the program within the school communities. A key aspect of the design process involved mapping out the everyday applications of mathematics within the Ngäbe community, including traditions, songs, children's games, and the use of mathematics and geometry in spirituality, cosmology, farming, art, and clothing.

Innovation

This mapping exercise drew insights from a diverse community group, including women and youth. Building on this mapping, an expert in Ngäbe mathematics and language collaborated with educators to structure the JADENKÄ program.

While ministries of education have long aimed to recruit and train more indigenous teachers, JADENKÄ offers an immediate solution to help currently enrolled children learn, even if they do not share a language with their teachers. JADENKÄ tackles the issue of limited indigenous language teachers by employing Interactive Radio Instruction (IRI) methodology, guiding educators in delivering engaging lessons that repeat key concepts in both languages.

These lessons incorporate a plethora of math songs, theatrical elements, and games. Notably, this marks the first time IRI has been employed to bridge the gap between indigenous languages and cultures. This innovative approach enables all children, including those who do not speak their teacher's language, to grasp both Western and indigenous mathematical concepts. The program has also shown improvements in logical thinking skills, students' enjoyment of mathematics, and their sense of belonging in mathematical pursuits.

Importance

The indigenous comarcas in Panama have the highest poverty rates in the country, and poverty is inextricably linked to the limited access to formal education. Census data reveals that only 2% of indigenous people have attained tertiary education, 13.1% behind the national average. While intercultural bilingual education is legally guaranteed, it remains largely unimplemented. The National System of Quality Assessment of Learning (SINECA) shows that: 46% of third-grade students lack even basic proficiency in Spanish, and over 75% fail to reach the basic level in mathematics.

JADENKÄ addresses the learning problem from the preschool level. If you do not acquire foundational skills in preschool, you do not have the skills you need to excel in first grade. By addressing the indigenous skill gap in preschool, students can enter first grade more ready to learn.

The transformation of preschool mathematics education is two-fold. First, JADENKÄ introduces intercultural bilingual education to indigenous preschoolers. Educators assigned to Intercultural Bilingual Education schools often lack proficiency in the indigenous language of their students and have limited knowledge of their culture. With the JADENKÄ program, preschoolers receive instruction in their native language and culture, incorporating the recognition of mathematical concepts within their daily lives and employing the traditional mathematical system rooted in their culture.

Second, preschool mathematics education across LAC often falls short in quality, particularly within schools serving economically disadvantaged children. Instruction in mathematics tends to revolve around oral counting, depriving students of the foundational mathematical skills crucial for any four to five-year-old preparing for first grade. These foundational skills include one-to-one correspondence for counting objects, recognizing basic shapes like triangles and circles, sorting objects based on characteristics such as color, comprehending the concepts of quantity (more and less), and identifying the next object in a basic pattern. JADENKÄ preschoolers opportunities to practice and develop all these skills through interactive and engaging mathematics lessons tailored to their age group.

Impact

JADENKÄ was evaluated through a randomized control trial as well as through a qualitative evaluation.

Quantitative findings. A stratified randomization approach was employed to allocate the 373 schools within the sample into a treatment and a control group. This randomized experiment unfolded across two separate cohorts of preschoolers in the years 2018 and 2019.

To assess the program's impact, standardized assessment tools were utilized during both the baseline and post-treatment phases. The results unequivocally demonstrate the program's positive influence on students' mathematical and ethnomathematical proficiency. While the initial year yielded improvements, the second year witnessed even more substantial progress. In 2019, the program exhibited an impact on mathematics ranging from 0.12 to 0.18 standard deviations (s.d.), signifying that student in the treatment group enhanced their mathematical skills by an additional half a school-year's worth compared to their peers in the control group. In the domain of ethnomathematics, the impact was even more pronounced, with an effect size of 0.23 s.d.

Furthermore, JADENKÄ impacted the cultural identity of the students. The impact was strongest on the ethnomathematics skills of students who primarily spoke indigenous languages and those whose teachers identified as indigenous – groups that traditionally exhibit lower learning levels in Latin America. Lastly, the program strengthened teachers' ethnomathematical competencies and enhanced their knowledge of the Ngäbere language and culture.

The findings establish that a well-designed intercultural bilingual education mathematics program has the potential to diminish the indigenous achievement gap without necessitating students to compromise between their academic pursuits and their identity, culture, and language.

Qualitative findings.

To assess the impact of JADENKÄ on instructional practices, we complemented the quantitative findings from the randomized control trial with a comprehensive qualitative evaluation conducted in both 2018 and 2019. This qualitative investigation involved classroom observations and semi-structured interviews with various stakeholders in the education process, including teachers, school directors, families, and program tutors. The primary objective was to delve into the methods employed in classes for both the control and treatment groups and to gain insights into the execution of the intervention.

The qualitative study was conducted in 22 schools, selected randomly from the overall pool of participating schools in the randomized control trial. To ensure representation, the selection of schools took into account factors such as the treatment allocation (8 from the control group and 14 from the treatment group), geographical location (10 within the comarca and 12 in neighboring areas), and the type of preschool (13 formal education and 9 nonformal education). To assess the approach taken in control group schools during mathematics classes, teachers were asked to prepare a mathematics lesson for the day of our visit.

The contrast in mathematical content and concepts between the two groups was stark. JADENKÄ preschool students were actively engaged in developing a wide range of early mathematics skills essential for a successful transition to first grade, including tasks such as number recognition, one-to-one correspondence, pattern recognition, and spatial relationships. In contrast, mathematics education in the control schools predominantly centered on oral counting—an approach as disconnected from the cultivation of mathematical thinking skills as reciting the alphabet is from fostering reading skills.

Qualitative findings.

The results of this qualitative evaluation also illuminated a greater emphasis on and appreciation for Ngäbe cultural elements within the treated schools. These elements included the Nagua (traditional dress), the Totuma (a traditional Ngäbe container), and the traditional dance known as Jeki. Furthermore, there was a notable increase in the use of the Ngäbere language as a learning tool and for providing instructions during classes. Most significantly, the treated schools incorporated Ngäbe mathematics, a component largely absent in the control schools.

Notably, these qualitative findings exhibited greater prominence during the second year of implementation, indicating that time is a crucial factor in the transformation of teaching practices, even when guided by an audio-based model.

The parental engagement component was only partially executed, indicating a need for greater support from coaches to facilitate its implementation. Only 36% of teachers reported providing parents with the math stories designed to reinforce classroom concepts. Among the teachers who did implement some aspects of parental engagement, 49% reported a positive and helpful experience in solidifying mathematical concepts. The limited implementation is likely influenced by an education system where parental involvement is not traditionally encouraged.

Feasibility and sustainability

Building upon the favorable outcomes observed in the randomized control trial, the Ministry of Education, with support from the IDB and in collaboration with the OEI, have expanded the reach of JADENKÄ within the Ngäbe comarca. This expansion encompasses a horizontal scaling to reach a broader audience within the comarca Ngäbe and a vertical scaling to include first-grade Ngäbere students. Additionally, following the positive evaluation results in Panama, the government of Peru has designed a Quechua version of the program, slated for implementation in 2024.

Interactive radio instruction proves to be highly cost-effective, particularly once the interactive audio lessons have been designed and recorded. It demands minimal teacher training since the audio serves as a guiding tool for teachers to conduct engaging, high-quality lessons in two languages. In contexts where teachers frequently do not share a common language with their students, this model provides an avenue for effective learning. Importantly, this model exhibits the potential for scalability, benefitting indigenous preschoolers not only in Latin America and the Caribbean but also around the globe.

The program's ease of replication is underpinned by its foundation in IRI methodology. The audio programs methodically cover various preschool mathematics topics in sequence, adhering to a content pedagogical master plan devised by a team of experts from the OEI, IDB, and the MEDUCA. This master plan ensures comprehensive coverage of all learning objectives outlined in a typical international preschool mathematics curriculum, which is also in alignment with Panama's preschool curriculum.

Feasibility and sustainability

To facilitate the successful implementation of the program, teachers are provided with a comprehensive set of materials listed below.

- A teaching guide furnishes essential instructions for executing the audio program effectively.
- Audio programs with recorded audio lessons are provided to teachers in the treatment group schools who receive 108 audio programs.
- Worksheets for preschoolers accompany each lesson and include post-lesson activities.
- A teacher evaluation format with questions related to the teacher's experience with the audio program is completed after each audio program session and allows coaching support to be tailored to the teacher's needs within the classroom.
- Five illustrated stories for each thematic unit of the curriculum are provided that reinforce both Western and Ngäbe mathematical concepts while promoting knowledge and attitudes that highlight the value of nature and indigenous culture. The involvement of parents is encouraged through these stories, inviting families to participate in the program. Parents use these stories to reinforce concepts already covered in class, providing an additional opportunity for consolidation.
- To ensure program implementation, radios appropriate for the context, are provided for the reproduction of the audio program. These radios are distributed to the directors of the treatment group schools, including solar panels to schools that lack electricity.
- Tangible mathematics resources are provided, such as counters, clocks, scales, solid geometric shapes, as well as paper, markers, pens, and crayons.

The program implementation begins with an initial two-day training for teachers, focusing on the utilization of audio lessons and post-audio activities (stories and worksheets). This initial training is supplemented by coaching visits aimed at providing ongoing support and monitoring. On average, each teacher received 3.3 coaching visits during the 2018 school year and 4.8 visits during the 2019 school year.

Cost Effectiveness.

The cost-effectiveness analysis, conducted in accordance with the guidelines outlined by Dhaliwal et al. (2013), reveals that achieving an impact of 0.10 standard deviations in student performance corresponds to an investment of US\$48 per student once the audio lessons have been developed. Scaling the program within the Comarca Ngäbe at the preschool level has proven to be relatively straightforward, given that the 108 audio lessons are already recorded, classroom materials are designed, tangible mathematics resources for each lesson are specified (e.g., counters, clocks, scales, geometric solids), a teacher training guide is available, and the necessary hardware for different contexts is well-defined (e.g., a small solar panel to power radios in schools without electricity).

Expanding the program to serve other indigenous communities requires contextualization and validation of the audio lessons. The government of Peru undertook this task to extend the program to Quechua-speaking preschoolers in 2024. This process involved 12 months of collaborative effort with pedagogical and Quechua language experts, actors, and singers.

This experience underscores the potential for the JADENKÄ model to be adapted and scaled to other education systems catering to indigenous students worldwide. The initial investment for contextualization and validation amounted to US\$400,000. Subsequently, the cost of scaling to other regions will align with that of the Ngäbere version, which is US\$48 per student, aiming to achieve a 0.10 standard deviation impact on academic achievement.

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