

**Integrating Math To Every Day Life:
Different Communication Strategies For A Continuous Challenge.**

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Abstract

There is a pervasive view in most societies that considers mathematics as a narrow field of expertise, open only to the more intelligent, mostly male participants of an elite part of the culture. On the one hand, formal education does not facilitate the incorporation of mathematical ideas and strategies in citizens' every day practices. On the other hand, though there are some successful math communication strategies in different parts of the world, their effect is very localized and in need of bigger spaces to present, discuss and learn from these experiences.

Here we share different perspectives, strategies and modalities used to communicate and involve people in mathematical activities sharing it's beauty, usefulness and connections with the arts, sciences, literature and technology. Traveling exhibits, mathematics through radio, podcast and blogs, mathematics festivals, math history through games, geometry and arts and more.

We concentrate on the experience in Costa Rica, through formal and informal means, to influence education and build a more scientific citizenship, to influence values and beliefs, to bring down the barriers around the use of mathematics in everyday life and to strengthen practices and positive views for everyone.

Introduction

Since 1990, through the Department of Popularization in the Ministry of Science and Technology in Costa Rica, a program was organized to support mathematics learning within the family and to strengthen the mathematical connections between the home and the school. The program named 'Family Math' or its Spanish version 'Matemática para la Familia' developed by the University of California at Berkeley, was chosen as the local strategy. Developing problem-solving skills and building a conceptual understanding of mathematics with hands-on materials were the basic goals of the program, which spread worldwide, building communities of practice in different countries.

At that same time a Costa Rican National Women and Science Committee was collecting data and orienting research to study the causes of the low participation of women in fields of science, technology, engineering and mathematics (STEM), and to find crucial links between career choices, cultural expectations, gender values and perceptions of personal performance in mathematics.

Since this area (math education) does not reflect the values and beliefs of women, it seems foreign to a majority of them. This could be an important factor with respect to the difficulties some women have with the subject, and for the low representation of women in technical careers. Silvia Chavarría (1994).

Today the numbers of women continue to be low in STEM fields not only in Costa Rica, but throughout the world, and one of the main barriers is mathematics.

A decade later, the influence of the Family Math approach and the research led to new math text books and a 'Family Math' course for educators throughout Costa Rica being offered by the National Distance University, UNED. The Family Math programs opened the door to rethink the importance of learning mathematics in a meaningful, non-competitive way, outside and inside the classroom. These programs influenced a change in the perception of math learning, that softened the dichotomy of right or wrong answers, opened the way to validate a diversity of problem solving strategies, promoted more play and enjoyment, recognized and incorporated more mathematical strategies in everyday life, and developed positive math messages in support of life long learning.

The Family Math group and the later ‘Equals’ program from the Hall of Science at the University of California at Berkeley was a strong influence in Costa Rica for many years. This exchange continued to foster an alternative way of thinking and learning mathematics, recognizing the barriers, supporting those in a position to influence young people’s choices, and advocating for more programs to communicate math to the general population.

This exchange sparked a biennial International Math Festival that started in 1998 to bring together K-12 teachers under one roof and offer them opportunities to advance, and also to climb out of their ‘boxes’ by expanding their command of the subject knowledge (especially in primary school) and confronting the limitations of traditional teaching methods (in both primary and secondary levels) that fostered fierce competition among students, exalted math proficiency as a higher intelligence, emphasized rote exercises instead of thinking skills, emphasized memorizing and following formulas, among others. This Math Festival also extended the benefits through workshops and activities towards families and the general public. In many occasions, the Festival included small fairs for the whole community involving games and resources to play and learn.

The Math Festival has continued since 1998 as a math teacher conference promoting a broader vision of mathematics, including interdisciplinary approaches inclusive of the social sciences and the arts. As an example, the field of Ethnomathematics was taken up by the universities as a result of the Festival. Subsequently, the field of Ethnomathematics evolved locally, with studies that incorporate Indigenous Costa Rican math models and validate their traditional ways of thinking.

Presenting the advantages that math offers for personal and professional advancement, not only to math specialists, was another line promoted by the Festival. As a consequence, biographies and stories of women were published by CIENTEC, Costa Rica’s Science Foundation, on their website. One of the most visited stories presents Florence Nightingale and her use of data and graphs to support a vital change in the health care system in the United Kingdom in the Victorian era (<http://www.cientec.or.cr/equidad/nightingale.html>).

Another example of the influence of the Math Festival in opening areas of research on education and communication of mathematics is ongoing research in the use of mathematics by university students of agriculture at the Instituto Tecnológico de Costa Rica, a study led by the co-author of this paper, Anabelle Castro.

From formal to informal means of communicating math

Throughout the world, anxiety and fear of math have been recognized as factors affecting learning, self esteem and personal development at different levels. In response to this, many science centers have developed math spaces, and math traveling exhibits. This move to bring mathematics to the public in an engaging way has many examples, one of them the ‘Geometry Playground’ developed in 2010 at the Exploratorium and now in the form of a traveling exhibit. Designed to provide ‘playful learning experiences’, it expanded its influence through the publication of resources on the internet in Spanish and in English.

Another example of this trend of engaging the public with mathematics is the National Museum of Mathematics in New York, an entire science center experience dedicated “...to *enhance public understanding and perception of mathematics...(to) stimulate inquiry, spark curiosity, and reveal the wonders of mathematics...(to) lead a broad and diverse audience to understand the evolving, creative, human, and aesthetic nature of mathematics.*” Among their programs, they also develop conversations on the role of mathematics in the lives of key leaders in different fields.

A smaller version of this initiative can be found in Catalunya, Spain, the Museu de Matemàtiques de Catalunya. In France and Brazil, an exhibit “Camino de las Matemáticas” by Francis Dupuis has been very influential. The Museum Universum in Mexico City and Questacon, Australia’s National Science and Technology Centre, have also developed math exhibits.

Meanwhile in Costa Rica, smaller versions of math exhibits and interactive resources for informal learning were developed by different groups.

One of CIENTEC’s early programs for the general public was a campaign developed in 2006 on cereal boxes with a corporate partner, Alimentos Jack’s, and published also on CIENTEC’s website under the topic ‘Problem Solving’

(www.cientec.or.cr/matematica/ejerciciosJacks/index.html). This first Math communication campaign aimed to validate different ways of solving problems and relate them to everyday challenges. Motivated by 'Concept Cartoons', three of the four designs showed different youngsters, boys and girls, arguing about simple challenges (different ways of measuring volumes, confronting bargains with percentages, and using fractions in a pizza). The goal was to provoke discussion and stimulate thinking, realizing that the cereal boxes would be on the family table, providing the opportunity to capture the attention of the kids and their parents. The fourth design in this campaign was dedicated to a newly designed board game that allowed players to practise and learn multiplication tables. This campaign with the cereal company reached four countries: Nicaragua, Costa Rica, Panama and the Dominican Republic. The published content on the website continue to attract hundreds of visitors per week.

Another strategy to link math with arts and engineering promoted by CIENTEC has been through origami, the Japanese art of paper folding. Workshops, Math Festival sessions and activities published on the web over many years have used origami as a strategy to provide visualization metaphors and guide the process of folding a figure (<http://www.cientec.or.cr/matematica/origami/transformaciones.html>). This has also been an attractive strategy to present geometry and promote innovation in three dimensions, developing the spatial sensory capacity.

Based on these experiences and a successful science podcast program produced by CIENTEC and the University Radio Station, Universidad de Costa Rica, a math podcast was developed and launched in 2010. Each math podcast, less than ninety seconds long, has been broadcast on the university radio station for adult audiences (96.7 FM) and shared with other radio stations in Spanish speaking countries.

This math podcast experience communicates bite size math stories, that the radio audience can hear and think about during the day. This has been successful in many ways. It has produced 55 radio and podcast resources that have gone to air and that have been published on the web. It has developed a set of initial goals for communicating math to the general public like: facilitating playful ideas linked to math; presenting math as an active discipline; relating math to everyday life; connecting math with other disciplines; showing aspects of math history and their relationship to other cultures; presenting a

diversity of areas and people who work in mathematics (especially women); supporting learning of difficult and non-intuitive concepts like exponential growth; showing the usefulness of math in problem solving; presenting technology's cognitive and logic requirements; cultivating analytical abilities; contextualizing the value of abstraction; presenting the aesthetic beauty and enjoyment in figuring out mathematical patterns; and presenting math as an accessible and social arena where life long learning is possible.

The math podcast 'Math for a Minute' program has also supported the growth of the math professors involved, expanding their communication skills in ways they did not foresee. This has been a benefit for their formal education work as well as promoting a recognition of the value of math communication in their institutions.

It is in this context that the International Math Festival and the 'Math for a Minute' podcasts have provided the base for a much larger proposal in math communication through the Public University Special Fund in Costa Rica. This new project for 2014 and 2015 will support the Math Festival to increase its public activities, the continuation of 'Math for a Minute' podcasts, and will support the development of a 'Science and Math Traveling Museum' that will be nourished by the growing community of math communicators.

Parallel to this, there are various projects to take the 'Math for a Minute' audio programs to other formats. A book with a CD and the production of videos based on the same scripts are two of the ways in which the programs will be extended and shared more widely.

Conclusion

Though the programs mentioned have been successful in growing the base for a better use and incorporation of math strands in everyone's lives, there is still much to do in the communication of mathematics to place it in the mind and the tool box of every citizen.

Math literacy, like science literacy, is critical for the wellbeing of individuals, communities and nations. Through the math initiatives described above, and through their socially inclusive approaches, Costa Rica is investing in the development of its human capital and contributing to its economic and social progress.

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