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Transforming Educational Practices through STREAM across the Americas

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Title: Transforming Educational Practices through STREAM across the Americas

Resumen: En este artículo, describimos la educación STREAM (ciencia, tecnología, lectura, ingeniería, artes y matemáticas) empleada en algunos de los países de América Latina y el Caribe como un enfoque integral de la educación. Específicamente, describimos un marco educativo STREAM, prácticas pedagógicas efectivas y ejemplos de programas basados en STREAM que incluyen BE-STREAMING en Surinam y talleres de RIED-STREAM en Jamaica, Bahamas y Belice.

Palabras clave: Formación docente, STEM, STREAM.

Abstract: In this paper, we describe STREAM (science, technology, reading, engineering, arts and mathematics) education employed in some of the Latin-American and Caribbean countries as a comprehensive approach to education. Specifically, we describe a STREAM education framework, effective pedagogical practices, and examples of STREAM-based programs including BE-STREAMING in Suriname and ITEN-STREAM workshops in Jamaica, Bahamas and Belize.

Keywords: Teacher Education, STEM, STREAM.

Introduction

Remember the quote, "The whole is greater than the sum of its parts"? Imagine how this can help transform pedagogical practices in education if individual successful strategies can be combined effectively to yield a combined vision that can help transform education. In this work, we will introduce such an integrated educational concept called STREAM that enhances the components of STEM by adding arts and reading with science, technology, engineering and mathematics. Specifically, we will share the impact STREAM has created in countries across the Americas which showcases the strength of ITEN and other similar partnerships to resolve regional issues in STEM teacher education.

The space race of the fifties in the Cold War era is believed to have forced the United States of America to place a new national priority on science education. A report to the President by Vannevar Bush, Director of the Office of Scientific Research and Development in July 1945 titled Science—The Endless Frontier became the prescription for government support for science. Following this, the Sputnik launch by the Soviet Union forced a national self-evaluation of the American education, scientific, technical and industrial strength of the nation. This prompted congress to respond with the National Defense Education Act of 1958 (Urban, 2010), which emphasized science education and became a significant part of the country's science policy. As the drive to create a new generation of scientists and engineers intensified, this would not only shift the national narrative around STEM education and job training, but mandate new technologies in classrooms along with training teachers to utilize such media with maximum effectiveness. Along with STEM, as years went, it also became clear that to prepare better scientists and engineers, teachers had to engage them in learning how to think artistically, and create the connection between STEM and the arts, leading to the development of STEAM education.

For Latin American and Caribbean countries, STEM has become an area of particular concern especially for skills development (Fiszbein et al., 2016). In addition, the results from the recent Program for International Student Assessment (PISA) administered by the Organization for Economic Development (OECD) to about 600,000 15-year-old students from 79 countries and education systems confirmed that LAC is facing a learning crisis. Specifically, the results showed that on average, 15-year-old students in the region are three years behind in reading, mathematics and science than any student in an OECD country. In addition, the results indicated that more than half of young people still do not achieve basic reading skills. This may be attributed to a variety of reasons including lack of meaningful instruction that integrates reading and literacy with the other independent domains in STEAM. This motivates the rationale and the need to integrate Reading/wRiting into STEAM, yielding a new area of education called STREAM.

Problem-based learning and Integration through STREAM

There are multiple studies on the innate ability of children to wonder about the natural phenomena they encounter and how these experiences can offer project-based learning (PBL) opportunities to spark their interest in the sciences (Milne, 2010). An interesting practical example to motivate a PBL STREAM activity could be to start with a visual prompt, for example, the picture of a butterfly as shown in Figure 1

FIG 1

Monarch butterfly as a visual prompt to initiate notice & wonder conversation (Woods, 2016).

The teacher can then invite the students to independently reflect on the visual prompt, which in this case is a butterfly and share with a partner or to the whole class on what they notice and wonder about (Watson, 2007; Barlow, 2020). Such open invitation can elicit responses by students which can range from noticing characteristics (such as type of butterfly, types of colors, the body parts) to wondering about their ability (such as how fast they fly, when and where do they fly from and fly to). As the students engage in this activity, the teacher can use this opportunity to open their minds to explore the famous Monarch butterfly and their migration patterns as they fly from North America to Mexico to avoid cold winters. The explore phase allows the students to investigate and find out more about these butterflies including their migration patterns (geography); speed at which they travel and the long distances they fly (mathematics); their life-cycle as they evolve form eggs to larvae to pupae to adults (science); ways to build gardens by planting native milkweed and protecting monarch habitat along roadsides, rights of way, and other public and private lands (engineering); learning how to engage in Google Earth tour of Monarch butterfly journey (technology); creating puzzles, games and art related activities (arts) and; finally being able to learn the

vocabulary for example, through crosswords or being able to reflect on what they learnt through a narrative (reading/writing). Some schools in the USA have included such activities to build butterfly gardens in their school to help foundational knowledge of students in STEM. Following this, the students are given an opportunity to explain their thinking, which helps them to reflect on their findings to their peers. Not only does this phase help students to collaborate but also communicate effectively. The explanations from the students with facilitated questioning from the teacher will then help students to elaborate on themes they may have missed by listening to their peers and also give them an opportunity to evaluate both self and their peers. This approach of engage, explore, explain, elaborate, and evaluate is known as the 5E-instructional approach (Duran and Duran, 2004) that can be combined effectively with STREAM to enhance student learning of any topic.

Teachers have also combined 5E-instrutional approach with STREAM through integrated lesson plans. Ms. Bhagya Malladi who teaches middle school grades 7 – 9, integrated science, physics, chemistry and biology, and food and nutrition in Jamaica is a Master teacher who participated in an ITEN teacher workshop series offered by the author. She commented on the impact of the 5E and STREAM integrated approach on her pedagogical practice as well as the improvement of student learning:

> In 2018, a three phase ITEN workshop on Transforming Teacher Professional Development in Best Practices through STREAM was organized by the Master Teacher unit of the Jamaica Teacher Council (Ministry of Education, Youth and Information) in collaboration with OAS. This workshop by Dr. Seshaiyer made me a learner for continuous improvement through the integration of subjects into a STREAM lesson plan, which also helped diverse learners. Through this workshop, I assumed the mantle as a leader to acquire the mastery of leadership skills. All the various tasks from the workshop honed these skills for me as a coach/teacher-leader and enhanced my pedagogical practices. I was able to enhance and support the NSC Curriculum through the 4C and the 5E, which are now important integrated components of STREAM in action. Besides enhancing my own teaching practice, I have used the STREAM approach to impact the learning of over 2000 students over the last two years and over 100 teachers that I have trained as a Master teacher. Most impact was on students that were slow learners initially but the combined 5E with STREAM approach helped them to gain confidence to work independently and achieve significant learning gains.

Impact of STREAM across the Americas

In 2016, a novel program titled BE-STREAMING (Basic Education-Science, Technology, Reading, Engineering, Arts and Mathematics to Improve the Next Generation) that was supported by the Inter-American Development Bank was created by the author as a national effort in Suriname to advance basic education and inspire the next generation of students, teachers and parents to become change agents for the country. Since its successful opening through a public festival that engaged the community, BE-STREAMING has now become a powerful approach to stimulate the interest of Suriname to create an integrated curriculum through STREAM by producing and presenting the most compelling, exciting, and educational activities for teachers and students. It has helped to address the importance of 21st century skills in all careers and everyday life that will help prepare a strong workforce for Suriname. Through BE-STREAMING, we have also helped to conduct year-round programming and curriculum development through educational activities at all levels. Most importantly, BE-STREAMING has helped identify key stakeholders from Suriname who can now lead and sustain the excitement the program has created!

FIG 2

BE-STREAMING Program implemented through MOESC, Suriname, Padmanabhan Seshaiyer (2016)

Figure 2 illustrates how a program goes through multiple phases. In the planning phase, a select group of local teacher facilitators (LTF) were identified that were trained by the author. Along with this all the 360 schools in the country were divided into local school sites and near each selected school site, cluster of schools were identified with the help of Ministry of Education, Science and Culture (MOESC) along with teachers from these schools as participants. Following that, through a training phase the author and the trained LTF were able to train more teachers through professional development activities. For example, some of these activities included creating PBL tasks with 5E-STREAM along with lesson plans and performance-based assessments. Next, an implementation phase allowed the teachers at the local school sites work with their LTF, to share effective practices with their students. Finally, an evaluation phase was conducted on understanding the impact of the program on growth mindset for the teachers along with improved student learning. This program also led to the creation of BE-STREAMING kits for each school with detailed program activities.

To establish such excitement starts by getting the members of MOESC excited. From 2016 – 2020, this program has overlapped with three different Ministers including former Minister Robert Peneux who is seen in Figure 3 inaugurating BE-STREAMING with the current Minister Marie Levens (elected in July 2020) as well Minister Lilian Ferrier (Figure 2) who maintained a two year term from 2018 – 2020. While there has been turn-over in the leadership, all the Ministers uniformly were excited about BE-STREAMING and wanted to see this program in all 360 schools. In fact, in April 2020, the MOESC announced the inclusion of BE-STREAMING into its national instructional plan to be delivered via TV and radio during school closures to all students across the country due to COVID-19.

FIG 3

BE-STREAMING Program inaugurated by former MOESC Minister Robert Peneux (MOESC). Standing next to him is the current MOESC Minister Marie Levens along with the author. Padmanabhan Seshaiyer (2016).

Another example of impact of STREAM was the second edition of the OAS-ITEN workshops in 2018 that involved inviting Ministries of Education of English-speaking OAS member states to implement STREAM based workshops and to co-certify the participants upon successful culmination of this activity. Three countries were selected to work with the author including Jamaica, Bahamas and Belize. Each of these workshops were based on a train-the-trainer model, targeted at principals, teacher leaders, curriculum developers and teacher professional development staff – selected by the Ministry. The theme was related to critical thinking skills and community development through STREAM. The ITEN workshops allowed teachers to also strengthen their ability to promote students' 21st Century skills including communication, collaboration, creativity and critical thinking skills and apply these in addressing problems in their communities. Teachers after participating in this workshop also helped to lead other teachers to learn methodologies from the workshop to foster students' capacity to identify a problem, collecting data and analyzing information, related to a problem in their local community.

After motivating problems connected to the UN Sustainable Development Goals (UN, 2015), the training included exposing about 40 teacher participants in each country to a variety of brainstorming and brain-writing tools including the Fermi approach to problem solving. This is characterized by not presenting all information, which apparently would be necessary for solving a given problem, and by being difficult to solve by using specific methods (Ärlebäck and Bergsten, 2013). Furthermore, participants also learned how to apply a human-centered design thinking approach (Brown, 2008), and several mind-mapping approaches including the affinity mapping technique along with a root-cause analysis using 5-Whys. Following the training, participants were expected to each train a group of at least ten more teachers on the techniques they learned from the ITEN workshops. Not only did this follow-up opportunity help the 40 workshop participants to reinforce the new pedagogical practices they had picked up but also it helped build capacity to about 400 teachers in each country engaged in learning about new instructional and pedagogical practices.

FIG 4

OAS-ITEN STREAM Workshop in Jamaica (2018)
Padmanabhan Seshaiyer (2018).

Figure 4 shows participants from Jamaica learning about failure through a marshmallow challenge; using various techniques, including a collaborative 6-3-5 brain-writing activity (Litcanu et al., 2015) to integrate and refine their lesson plans; teacher participant sharing enhanced lesson plans through the 5E-STREAM approach; and showing a teacher who impacted at least ten other teachers as a follow-up activity.

FIG 5

OAS-ITEN STREAM Workshop in
The Bahamas (2018)
Padmanabhan Seshaiyer (2018).

Figure 5 shows teachers from The Bahamas engaged in an affinity mapping with post-it notes combined with "5-whys" technique (Voehl, 2016) which helped them to identify extrinsic factors and intrinsic factors connected to challenges in their educational system and how to leverage and identify potential opportunities. Also shown is a teacher building a prototype of a drone through which all participants were taught how to incorporate a learning by doing framework combined with STREAM to engage students in state-of-the-art technologies.

FIG 6

OAS-ITEN STREAM Workshop in Belize (2018) (Courtesy: Padmanabhan Seshaiyer)

Figure 6 shows similar activities shared with members in Belize. One important observation included differences in the gender of the teacher participants in the countries that participated. In particular, the percentage of male participants from Belize was fifty percent while male participants in Jamaica and Bahamas was under ten percent. Such topics also stimulated many interesting conversations.

The examples presented demonstrates why STREAM education helps teachers become designers and students become creators. STREAM is even more impactful if the curriculum aligns with the local context. For instance, instead of the butterfly migration PBL activity discussed earlier for the North Americas, for a country like Costa Rica, it could relate to re-growing and restoring forests that are helping hundreds of species thrive as well as helping cultivate agricultural products. One may also consider contexts that connect to impact of natural disasters such as hurricanes or spread of diseases such as COVID-19 that not only helps to promote the much needed awareness of integrated approaches like STREAM but also helps engage young minds think critically and creatively about real-world problem solving.

References

Ärlebäck, J. B., & Bergsten, C. (2010). On the use of realistic Fermi problems in introducing mathematical modelling in upper secondary mathematics. En R. Lesh, P. L. Galbraith, C. Haines, & A. Hurford (Eds.), *Modeling Students' Mathematical Modeling Competencies* (597-609). Dordrecht: Springer.

Barlow, A. T. (2020). Notice and wonder. M*athematics Teacher: Learning and Teaching PK-12, 113*(5), 350-351.

Brown, T. (2008). Design thinking. *Harvard Business Review*, 86(6), 84.

Duran, L. B., & Duran, E. (2004). The 5E instructional model: A learning cycle approach for inquiry-based science teaching. *Science Education Review*, 3(2), 49-58.

Fiszbein, A., Cosentino, C. & Cumsille, B. (2016). *The skills development challenge in Latin America: Diagnosing the problems and identifying public policy solutions.* Washington, DC: Inter-American Dialogue and Mathematica Policy Research.

Litcanu, M., Prostean, O., Oros, C., & Mnerie, A. V. (2015). Brain-writing vs. vrainstorming case study for power engineering education. *Procedia-Social and Behavioral Sciences, 191*, 387-390.

Milne, I. (2010). A sense of wonder, arising from aesthetic experiences, should be the starting point for inquiry in primary science. *Science Education International, 21*(2), 102–115.

UN: United Nations. (2015). *The 17 Goals*. Recuperado de https://sdgs.un.org/goals

Urban, W. J. (2010). *More than science and sputnik: The National Defense Education Act of 1958.* Tuscaloosa, AL: University of Alabama Press.

Voehl, F. (2016). The 5 whys. En H. J. Harrington & F. Voehl (Eds.), *The Innovation Tools Handbook, Volume 2: Evolutionary and Improvement Tools that Every Innovator Must Know*. New York: Productivity Press.

Watson, J. (2007). The Invitation to Notice and Wonder. En S. Shelton-Colangelo, C. Mancuso, & M. Duvall (Eds.), *Teaching with joy: Educational practices for the twenty-first century* (77), Lanham, MD: Rowman & Littlefield Publishers.

Woods, E. (2016), Lack of milkweed Is not harming monarch butterfly populations [Image]. *Entomology Today*. Recuperado de https://entomologytoday.org/2016/04/29/lack-of-milkweed-is-not-harming-monarch-butterfly-populations-new-research-suggests/

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