STEM EDUCATION IN IRELAND AND BRAZIL SCHOOL SYSTEM: 
ANALYSIS AND RECOMMENDATIONS

Larissa Cristina Cruz Brum¹
Doutora em Cognição e Linguagem /UENF
Mentoring and Leadership for Schools/MIC-IE

Fabio Machado de Oliveira²
Doutor em Cognição e Linguagem /UENF

Abstract

The development of STEM (Science, Technology, Engineering and Mathematics) competences has been for the last decade one of the main goals of the schools’ educational agenda in most countries. STEM learning approaches prepare students for the future workforce, develop their creativity and innovative thinking. The main objective of this research is to explore and examine how STEM programs are designed for schools in macro and micro levels for primary and post-primary education in Ireland and Brazil. The study focuses on the STEM education literature found in national policies and journal articles. It seeks to investigate how STEM national strategies and local initiatives foster schools’ curriculum and engage students in the STEM learning approaches. The findings show that Brazil does not have a national policy for STEM as Ireland does and offer recommendations based on these findings. It also summarizes the main objectives of STEM national policies as it describes some micro-level actions in STEM programs across the analyzed countries.

Keywords. STEM education; STEM policy; Brazil and Ireland

¹ IFFluminense, Campos dos Goytacazes-RJ, lbrum@iff.edu.br
MIC – Mary Immaculate College, Limerick-Ireland
² IFFluminense, Campos dos Goytacazes-RJ, lbrum@iff.edu.br
MIC – Mary Immaculate College, Limerick-Ireland
INTRODUCTION

The acronym STEM (Science, Technology, Engineering and Mathematics) was originally introduced in 2001 by the US National Science Foundation in a political context to draw attention to the demands of the future workforce in these fields. It was defined as a set of independent disciplines. Later, educators recognized STEM as an integrated, interdisciplinary approach to learning in which four disciplines could be used in combination to provide hands-on and relevant learning experiences for students. Since then, STEM-focused curriculum has been extended to many countries with different concepts, programs and strategies for all levels of education: from early child education to graduate programs. According to Berker et al. (2011), STEM is getting so much attention for the last decade because it moves beyond simple-task performance focuses on developing higher level thinking skills by connecting class’s learning to the real world. It emphasis in collaboration, communication, research, problem-solving, critical thinking and creativity.

The OECD (2019) report, teaching and learning process with STEM goes beyond the transferring of knowledge. It engages students with critical thinking, problem solving, creative and collaborative skills. There is growing concern that students have not been prepared to address the grand challenges and skills of the 21st century. Some of the key issues regarding to STEM education at schools are the unmet labour needs, low PISA performance in America and Europe, the lack of innovative teaching approaches and the low attractiveness of STEM studies and careers.

This research analyzes some macro and micro policies main objectives in STEM education across Ireland and Brazil as it outlines important strategies and good practice that could be shared between these countries.

1. An Overview of STEM Education in Ireland

In general, Irish students are above the OECD average specifically in Maths and Science at the Programme for International Student Assessment (PISA) (OECD, 2019). However, their performance is low comparing to students in countries where STEM programme is outstanding. To get better outcomes, Irish’s education
department decided to have a strong National STEM programme to underpin high levels of student engagement and excellent performance in STEM disciplines.

According to the STEM Education Policy Statement 2017-2016 (Department of Education and Skills, 2017c), Ireland ambitiously target the “best education and training service in Europe within a decade” (ibidem, 2017c). To realize this, they will focus on the most effective and engaging teaching, learning and assessment environment for STEM education at all levels. The Department of Education and Skills (DES) addresses three main macro policies in STEM education: (1) STEM Education in the Irish School System (2016); (2) STEM Education Policy Statement 2017-2026 and (3) STEM Education – Implementation Plan 2017-2019 (Fig. 1).

![Figure 01 - Ireland’s three Macro Policies for STEM.](https://www.education.ie/en/The-Education-System/STEM-Education-Policy/)  
Source: DES (Department of Education and Skills)³.

In the Action Plan for Education (2017), it was outlined the development of the STEM Education Policy statement 2017-2016 (2) with an accompanying Implementation Plan (3) (Department of Education and Skills, 2017b). The development was informed by research, consultations and the STEM Education in the Irish School System Report (1) published in November 2016. The Implementation Plan (3) will take place over three phases:

- Phase 1: 2017-2019, Enhancing

(Accessed 15 Nov. 2019)
• Phase 2: 2020-2022, Embedding
• Phase 3: 2023-2026, Realising

Phase 1 encompasses the four pillars of policy development and action identified in the Policy Statement They are: Pillar 1. Nurture learner engagement and participation Pillar; 2. Enhance early years practitioner and teacher capacity; Pillar 3. Support STEM education practice and Pillar 4. Use evidence to support STEM education. For each phase, an Implementation Plan will be designed and will provide timelines and responsibilities in respect of each of the actions set out.

The literature review shows some informal and extra-curricular STEM initiatives that focus on STEM skills but sometimes they are teacher-dependent or dependent on the local engagement with enterprise (STEM Education Review Group, 2016). These activities include local school projects, visits, exhibitions, Science festivals, Science week, Maths Week, and competitions local, regional, national, and international.

2. An Overview of STEM Education in Brazil

Although it was not found any National Policies for STEM Education, the approach is inferred in the National Science, Technology and Innovation Strategy for 2016-22, the National Education Plan 2011-2020 and BNCC (Common National Curriculum Base - *Base Nacional Comum Curricular*) (Brasil, 2018), the document that sets up the skills (general and specific) and essentials learning that all students should develop during each stage of basic education - early childhood education, primary and post-primary education. The BNCC also determines that these skills and content should be the same regardless of where children, adolescents and young people live or study. Those skills and content encompass the STEM approaches.

There is a lot of work ongoing across the country at all levels of education in research centres and private schools regarding to STEM teaching and learning. A current outstanding program called “STEM Brasil” was founded in 2009 by an NGO – Worldfund to inspire, engage and support teachers from public State schools in STEM skills. The NGO has trained over 6 thousand teachers in 17 Brazilian states and also in Mexico.
In Brazil the Federal Network of Vocational, Scientific and Technological Education (Federal Institutes – Ifs) are responsible for significant advances in Brazilian education, with a strong focus on innovation, inclusion and internalization (OEDC, 2015). These Institutions represent a revolutionary proposal for vocational and technological education, in which teaching, research and extension are always combined. Currently, there are 41 Institutes, 664 campuses, 11,000 courses and over 6,000 technical projects across the country. The various federal institutes have different purposes and characteristics, but every development of applied research aimed at solving community problems and technology transfer and teacher training. Indeed, IFs have played an important role in STEM approach across the country.

3. Micro Policies in Brazil and Ireland

There are many informal and extra-curricular STEM initiatives in Brazil and Ireland with an outstanding impact on education process. However, these initiatives are not uniformly distributed in the country. There are also excellent projects conducted by students, teachers but it seems that STEM activities are undervalued by the education system because it is not integrated into the curriculum or assessment. Most of the local initiatives includes contributions from business and industry, NGOs, Associations, learned societies, organisations, social enterprises, science centres, teachers, volunteers and government agencies. Tables 2 and 3 gives some examples of STEM activities across the two countries. It was selected some important publicized projects on the Internet. It should be mentioned that all STEM educational initiatives were typified in the following categories, based on their activity and potential:

(1) Knowledge and contact with the professional environment
(2) Extra-curricular activities
(3) Outreach Activities
(4) Teaching Innovation, Methodology and Resources
(5) Continuous Professional Development for teachers

Table 01 - STEM Initiatives in Ireland
<table>
<thead>
<tr>
<th>Initiatives</th>
<th>Objective</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>The BT Young Scientist and Technology Exhibition (BTYSTE)</td>
<td>Annual and awarded showcase projects</td>
<td>1,3</td>
</tr>
<tr>
<td>SciFest</td>
<td>A science fair</td>
<td>1,3</td>
</tr>
<tr>
<td>CoderDojo</td>
<td>a community of free programming clubs for young people aged between 7 and 17</td>
<td>1,2,4</td>
</tr>
<tr>
<td>Coolest Projects Awards</td>
<td>an annual showcase event for projects created by young people in CoderDojo</td>
<td>1,3</td>
</tr>
<tr>
<td>MATHletes or Learnstorm</td>
<td>A competition from 4th class in primary school to 5th year in secondary school</td>
<td>1,3</td>
</tr>
<tr>
<td>The Intel Mini Scientist Exhibition</td>
<td>A fair programme for Primary school students</td>
<td>1,3</td>
</tr>
<tr>
<td>RDS STEM Learning</td>
<td>A peer-to-peer continuous professional development programme</td>
<td>5</td>
</tr>
<tr>
<td>Smart Futures</td>
<td>Promotes STEM careers to second-level students, parents, guidance counsellors, and teachers</td>
<td>1</td>
</tr>
<tr>
<td>Science Forward</td>
<td>Brings the world of science and third education closer to primary students in disadvantaged schools</td>
<td>1, 2, 3</td>
</tr>
</tbody>
</table>

Source: Adapted from Telefonica Fundación, 2019.

Table 2. STEM Initiatives in Brazil.

<table>
<thead>
<tr>
<th>Initiatives</th>
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IRELAND

BRAZIL
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<thead>
<tr>
<th>Apps for Good</th>
<th>An App that links open source technology education with real problem solving</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDI (committee for democracy in information technology)</td>
<td>Creates informal spaces, linked to institutions and local communities leaders, which combine inclusion and technological education with citizenship training and entrepreneurship.</td>
<td>1, 2</td>
</tr>
<tr>
<td>Espaço Ciência Viva</td>
<td>The first participatory science museum in Brazil focused in bringing science closer to the average citizen through non-formal education.</td>
<td>2, 3</td>
</tr>
<tr>
<td>C.E.S.A.R.</td>
<td>A company that develop products and services for businesses using ICT.</td>
<td>1, 3</td>
</tr>
<tr>
<td>STEM Brasil - Worldfund</td>
<td>focuses on teacher training. critical-thinking, and forming close bonds between the teacher and the students</td>
<td>4, 5</td>
</tr>
<tr>
<td>Escolas Conectadas</td>
<td>offers free online continuing education courses for primary school teachers.</td>
<td>1, 4</td>
</tr>
</tbody>
</table>

Source: Adapted from Telefonica Fundación, 2019.

Although there has been much research on STEM education, Tables 1 and 2 show that most projects and initiatives were classified into the 1 and 3 categories. It points out that, in general, STEM projects link the business world to the educational world through student’s activity programs: mentoring, role modeling, competitions, visits to the professional environment, conferences, development of scientific-technological projects, etc. Outreach Activities can be found in practical videos, published on the network and made by the students themselves; or science or math
museum activity programs. The common point is accessibility and the goal of bringing STEM knowledge closer to society and raising awareness about its social importance.

**FINAL CONSIDERATIONS**

This work underlies the need of improving STEM education in all educational levels as it prepares students with the skills sets required for success. Policymakers have recognized the value of STEM for students’ development and most high educational performance countries are aware about the decreasing of students in applying for STEM programs and low performance in STEM skills. The program is growing rapidly in many countries, but less in public schools in Brazil. The findings show that Brazil does not have a national policy for STEM but, on the other hand, it seems that there are a huge number of micro initiatives at all levels of education both in Brazil and in Ireland.

Based on the evidence currently available, it seems fair to recommend four micro initiatives to be implemented in Brazil, more specific in a Federal Institute:

(a) Develop a STEM education policy for the Institute through a consultation process. The Policy Statement should go beyond Science, Technology, Engineering and Mathematics to take account of the role of the Arts. Thus, the acronym STE(A)M should be considered, where A represents the Arts and Design (including design thinking).

(b) Create a collaborative website in the COIL (Collaborative Online International Learning) model to disseminate insights and best practice in STEM Education. This Virtual Exchange would enable authentic opportunities for intercultural and transnational learning to students. Through co-developed and co-taught modules, this initiative will support the development of 21st-century workforce skills and provides opportunities for applied learning experiences;

(c) Bring students from primary and post-primary schools closer to the Institute;

(d) Develop a program for Continuous Professional Development for teachers based on STEM-methodology-related subjects;
Include STEM on BNCC formative itineraries program. According to BNCC for Secondary school, formative itineraries are kind of training courses composed of a set of curricular subjects offered by schools or from educational networks, which enable students to be prepared for further study or future workforce. It would introduce a new teaching and learning modalities to enhance STEM education in the Institute.

The recommendation actions would aim at ensuring Brazil has a high-quality education output aligned with national economic needs now and into the future. They would also raise student`s performance in exams and encourage them to seek STEM fields.

REFERENCES


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