STIMULATING REGIONAL ECONOMIC DEVELOPMENT: A CASE FOR INFORMAL SCIENCE EDUCATION

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Abstract: The Purpose of this paper is to propose a collaborative model in support of the sustainable economic development of Small Island Developing States (SIDS) in the Caribbean through the collaboration of The National Institute of Higher Education Research, Science and Technology and Tertiary Level Institutions (TLIs) in the Caribbean in an eco-system which outputs informal science education technologies. The methodology utilized in the development of this paper is mainly desk research of literature which link economic development to education. The findings suggest that the early introduction of students to science education impacts their choice and curricula, and a curricular which supports the knowledge economy is one which will foster economic sustainability in the modern world

Keywords: *CARICOM, NIHERST, Economic Development, Science Education*

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1. Introduction

Traditionally the Caribbean Region has earned its revenue from either the exporting of primary products, such as agriculture, and minerals, or from tourism activities. In Trinidad and Tobago, the main export since the 1970s has been in the petrochemical domain. As the phenomena associated with global warming and the negative impact of terrorist activities increase, these prevailing forms of income are diminished. For Trinidad and Tobago, economic shocks caused by the depression of oil and gas prices have led to a stagnated economy, increased unemployment and increased migration of trained professionals.

Most countries which belong to the Organization for Economic Co-operation and Development (OECD) have passed through three phases in the last century; Industrialization, Post-Industrialization and now the new economy known as the Knowledge-based Economy. Economic success in the knowledge based economy has been identified as being hinged upon the development of human capital [5]. In the Global competitiveness Indices, the Caribbean Region (including Latin America) continues to perform well below regions in other parts of the world on all 12 pillars [4]. Informal science learning experiences has been known to influence the development of science curiosity and motivation to learn science more broadly. Early informal science learning involvements have been highlighted in analyses as to the reason for students making science-related curriculum and career choices, which supports the knowledge economy and will therefore economic development [1].

2. Changing Paradigms

To mitigate economic shocks, it is necessary that the Caribbean Region seek to develop its human capital in a holistic manner. Education curriculum based on Science Technology (Art) Engineering and Mathematics would aid in this development process and thus facilitating greater participation of the Region in the Knowledge-based Economy.

2.1 Global Competitiveness

The knowledge economy corresponds both to the theories of endogenic growth; that economic growth is primarily the result of endogenous and not external forces. Endogenous growth theory holds that investment in human capital, innovation, and knowledge are significant contributors to economic growth, and especially to the alternative directions for contemporary socio-economic approaches to the theory of growth. Theories incorporating the knowledge economy place an emphasis on the importance of knowledge, information and technical skills as the basic resource for the development of the economy. This is the precondition for a so-called resource approach to the creation of a competitive advantage where know-how is considered to be the most significant of the production factors [5].

Almost all of the factors on which the Global Competitiveness Index, as seen in Fig. 1, are derived from economies having the know-how. Innovation, Research and Development expenditures and the investments in technology are premises for ensuring competitiveness and progress and through them sustainable economic growth. An educated workforce, increased investments in research, the creation of the new products, firstly ensures the development of both the private and public sectors, and secondly, improves the living conditions of a nation’s population [2].

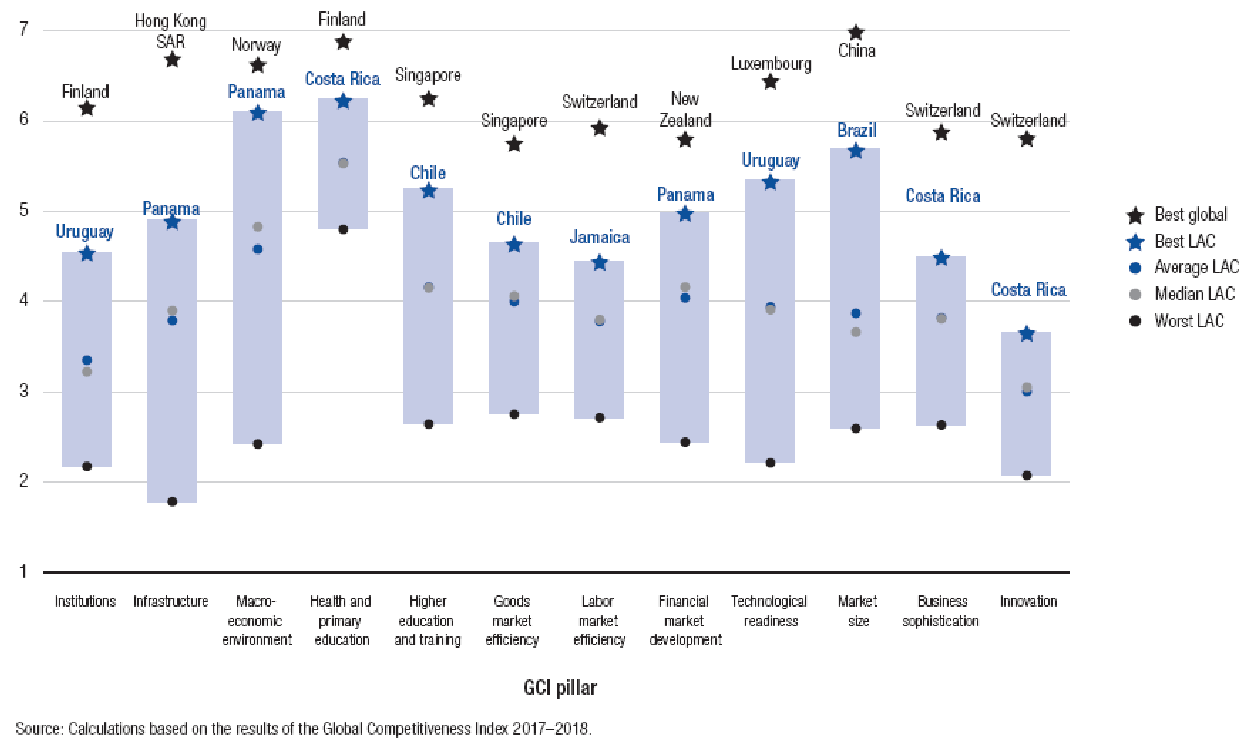

Figure 1: GCI score range for Latin America and the Caribbean (LAC) across the 12 pillars, 2017–2018

2.2 Informal Science Education

Science can be learnt in either a formal or an informal manner. Formal science learning usually takes place in a school context, while informal science learning refers to students' learning experiences in various non-school contexts such as museums, out-of-school or after-school clubs or programs, science camps, and various media [2]. Informal science learning has also been connected to other labels such as free-choice or outdoor education, with a common emphasis on such activities as being more self-directed, rather than strongly facilitated by parents or teachers.

Self-directed learning is the cornerstone of the contemporary STEM, which was originally called Science, Mathematics, Engineering and Technology (SMET) [3], and was created by the National Science Foundation (NSF). This educational initiative was to provide all students with critical thinking skills that would make them creative problem solvers and ultimately more marketable in the workforce [6]. Beals attributes the successes of the early innovators such as Thomas Edison, and Henry Forde, as being due to STEM. He describes Edison and Forde as being only slightly educated and/or were in some type of apprenticeship [6]

Scientific reasoning ability can be seen from various perspectives, ranging from a logical framework to the method of modelling the world. It can be thought of as a sense-making process which enables learners to interact with various information sources to extract useful knowledge.

Such a conception is consistent with science learning in diverse formal and informal settings, both as what habits of mind learners might acquire from informal learning and how learners may productively learn science knowledge from informal and formal sources. Scientific sense-making involves cognitive actions such as being able to interpret common data representations, focusing on mechanisms underlying empirical relationships, considering alternative explanations, and using evidence to select among explanations, which are aligned with the practices of science. As such, it can serve as a critical starting point for developing more scientific ways of thinking, engaging in an adaptive process to progressively reconstruct experiences and ideas, and to connect experiments, arguments, and representations in science [1].

2.3 National Institute of Higher Education Research Science and Technology (NIHERST)

NIHERST has its foundation in Act Number 20 of 1984, enacted by the Government of the Republic of Trinidad and Tobago. To date, NIHERST is the only statutory body in the English speaking Caribbean which can boast of having a science center, commonly known as The National Science Center (NSC). At the NSC, the public is allowed to participate STEM activities in various scientific domains. NIHERST has been able to develop and deliver camps, school science clubs and other activities for learners from pre-school age to tertiary learners.

NIHERST's success has led to formalized collaborations with many local, regional and international organizations. Perusing NIHERST's website reveals programs such as Rain Water Harvesting, in which communities are trained to design, build and install rain water harvesting systems to provide water for their homes and public centers. There is the First Lego League Competition, in which teams and schools compete annually to represent Trinidad and Tobago on the international stage, and the NASA Internships where tertiary level students are given opportunities to spend 10-weeks at various NASA research centers. NIHERST has been critical in the establishment of STEM, Science and Robotic Clubs in secondary schools and in the training of teachers to deliver their science curricula using STEM philosophies.

3. The Proposal

In order to foster and accelerate economic growth in the Caribbean, the dissemination of scientific knowledge and skills is a must. The socio-economic survival of the region is highly dependent upon the region's ability to innovate in various fields, develop and commercialize indigenous products and develop citizens with the mind set to research and critically assess problems and develop and implement appropriate solutions.
The objectives which are to be derived from the development of this eco-system are as follows:

- Exposing the citizens in the SIDS to STEAM Curricular at an early age.
- Eliminating or mitigating the stigma associated by static exhibits over time
- Challenging the students at the TLIs to solve Teaching/Learning Problems through the application of their training.
- Reducing the cost of informal education to those territories which cannot presently afford.
- Stimulating problem solving and technology creation among the youths of the Caribbean.

The proposed methodology includes utilization of the current Chair in CARICOM, with the responsibility for Science and Technology, along with the various ministries of Science and Technology and professional bodies with an interest in STEAM education to leverage the available funds and human resources, to develop enforceable policies which can assist in catapulting the Caribbean Region further ahead in the knowledge economy.

3.1 The Collaborative Core

NIHERST in its 35-year existence has a machine shop and a Creative Design Lab or Fab Lab which facilitates the creation of prototypes. NIHERST however does not have the skill-base to design all of the artefacts and activities needed to continuously capture the imagination in the evolving learner. To facilitate this, it is recommended that NIHERST collaborate with The University of the West Indies, The University of Trinidad and Tobago to design and build the interactive artefacts. While, it monitors the evolution of technologies and the training requirements for individuals wishing to succeed in the knowledge economy.

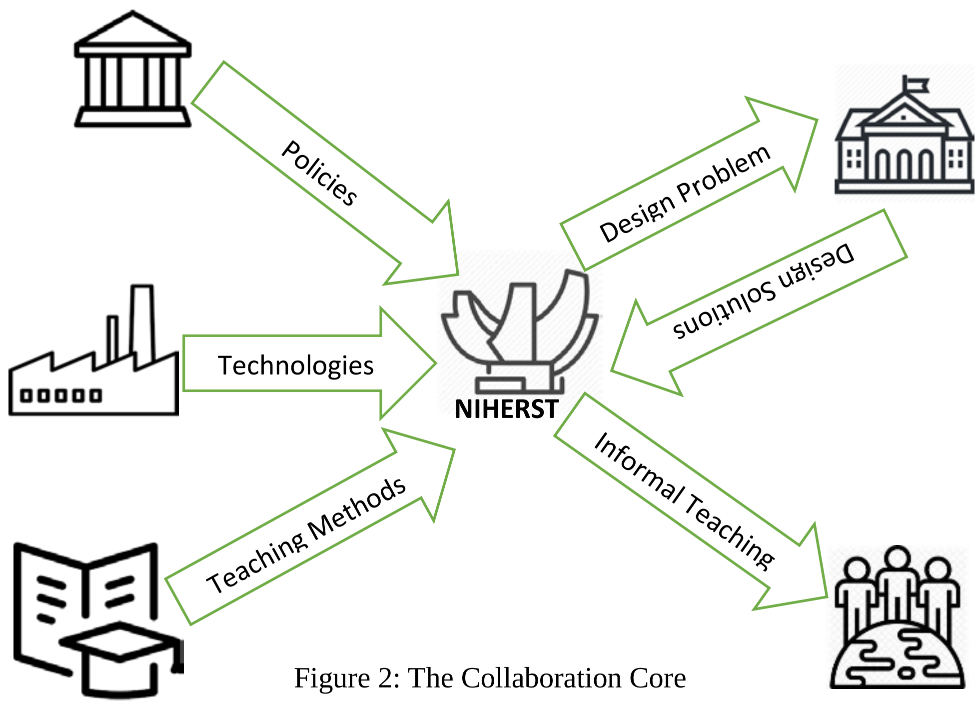

Figure 2: The Collaboration Core

Figure 2 shows the *Collaboration Core* which is designed to take policies, from governments; technology and technological needs from industry; Curriculum needs from educators and turn them into Design Problems. These design problems are then communicated to the universities, where students work on developing solutions. The design solutions are then returned to NIHERST and integrated into the various program and disseminated for public consumption.

3.2 Regional Responsibility

One of the major complaints of visitors to science centers and museums is *"seeing the same exhibits time and time again!"* This aspect of the proposal seeks to ensure that the exhibits are refreshed on a fixed cycle.

The proposal is to establish Science Centers in the various regional territories. On a fixed cycle, a portion of the exhibits in Trinidad are replaced. Those which are being replaced are then installed in the second science center in the chain. On the next cycle, again another portion of the exhibits in Trinidad and changed, and those which are removed are again sent to the second science center in the chain, and those which were in the second science center are now sent to the third science center. This cycle ensures that the exhibits at the science center aren't stagnant, and that the cost of acquiring exhibits for display are minimized.

As an extension of this program, it is envisaged that the staff of NIHERST can be rotated through the various island territories to train the locals in managing the science centers, and in the delivery of STEM Camps and workshops. It is expected that with the establishment of the science centers in the various territories, coupled with the STEM Training, that the development of indigenous technologies and products will result, thus leading to economic growth and social enhancement.

4. Conclusion

Fostering economic growth and social advancement is difficult on our island territories as the necessary education principles are omitted in preference to more critical needs such as food imports and health care. The creation of a network of science centers, which are linked to the universities could provide a low cost and culturally appropriate mechanism for infusing the STEM philosophies needed to transform the region into one that is knowledge driven, which will result in the critical mass of human development needed to stimulate economic growth [5].

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