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CARIBBEAN ASTRONOMY FOR INCLUSION (CAI): TRANSFORMING "THEORY" ON INCLUSION INTO CONCRETE ACTIONS

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ABSTRACT

Astronomy is the most fascinating science for the general public, and one of the most interdisciplinary existing subjects. This makes Astronomy an ideal subject to work on accessibility because through the teaching of Astronomy we can access a wide range of other topics. The population with disabilities is large, with high rates of unemployment. The main objective of CAI is this population, even in the most early stages of education. We are looking to provide accessible resources for the students with disabilities and reduce the gap that already exists in the professional field of Astronomy in our region, the Caribbean.

RESUMEN

La Astronomía no es sólo una de las ciencias que más fascina al público en general, sino que también es una de las áreas más transdisciplinares que existen. Esto hace que la Astronomía sea una asignatura ideal para tratar la accesibilidad en el aula a la vez que enseñanos una amplia gama de temáticas. Se sabe que la población con discapacidad es numerosa y con alta tasa de desempleo. El objetivo de CAI es esta población, aún en el nivel educativo más temprano. Se busca brindar recursos educativos accesibles para los estudiantes con discapacidad y ayudar a reducir la brecha que existe en el campo profesional de la Astronomía en nuestra región, el Caribe.

Key Words: astronomy education — inclusive astronomy

1. INTRODUCTION

The Caribbean is the definition of diversity. Crowned by the fusion of ethnic and cultural origins, the Caribbean countries frequently face localized natural disasters, which increase impact factors such as deaths, injuries, and homelessness. The number of affected populations, human development, and access to resources that are necessary for social, communal, economical and physical well-being are strongly affected. These factors could especially impact the human and social development of people with disabilities and/or impairments of functional diversity, and the assessments each country carries out on this population. Likewise, the reality of the physical and geographical location of many Caribbean countries (i.e., surrounded by water as small island nations) affects the availability of adequate natural resources which could impact common access and therefore the well-being of the people. An emerging initiative of astronomers from the Caribbean region, with first hand experience and recognizing the impact of these factors in the lives of all peoples, has been formed to focus on a population that is socially vulnerable - people with disabilities/impairments or functional diversity. There is special focus on 1. educational aspects (i.e., literacy and literacy in STEAM) and 2. unemployment (targeting STEAM representation).

Our region shares with the rest of the world a disproportionately high number of unemployed persons with disabilities (See Fig. 1). In Trinidad and Tobago, for example, more than 90% of the population with a disability is unemployed (Seetahal & Charran 2018). In Puerto Rico, the unemployment is around 80% (Erickson et al. 2019), and according to surveys from 2013 in Dominican Republic (Tactuk 2014) and Haiti (FIRAH 2012) this number is around 60%. In the Honduran case, according to surveys from 2009 (CONADEH 2012), the number of un-

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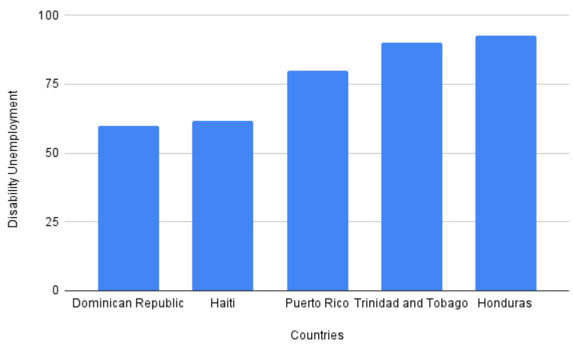

Fig. 1. Unemployment in the Caribbean countries within CAI.

employed population with disabilities is between 90-95%, with an approximate percentage of insertion in the labor market of 50.08% among men and 27.61% in the case of women, being clear the gender as a new variable in the problem we are studying. According to the World Health Organization (WHO), a specialized agency of the United Nations responsible for international public health, 15% of the world population has some kind of disability (WHO 2011); and as stated by UNESCO, 90% of children with a disability do not attend school (UNICEF 2016). It is important to note that these low numbers of employed persons with disabilities may be a reflection of late onset persons with disabilities. That is, a high probability that persons with disabilities reported as employed entered the disability spectrum either after getting a job or after finishing their education. Targeting transitions into the work field, skill acquisition and capacity building, our goals are to create a community where Astronomy and its practices are promoted among persons with disabilities by offering materials, resources, training, etc.

2. COUNTRIES IN CAI

We have a rising number of countries in the initiative, at the moment the participant nations are: Trinidad and Tobago, Haiti, Puerto Rico, Honduras and Dominican Republic. In each county we are creating a working team that will put into action the vision and mission of CAI. Of course, we are working to include as many countries as possible from the Caribbean region.

3. GOALS

The main goal is to create an integrated community to share and promote the science of Astronomy and its practice among persons with disabilities in the form of (but not limited to) access to materials, resources, and methodologies. For this purpose, we will reach out for the organizations serving our target community on different Caribbean countries. Moreover, the group will seek to increase accessibility for mainstreaming to address and close the existent multifactorial deep abyss that currently exists among peoples with disabilities and the Astronomy field of practice in the Caribbean.

4. ACTION PLAN AND TOOLS

Our plans include creating a repository of materials and offer courses on didactic accessible Astronomy. We aim to expand to as many Caribbean countries as possible and create connections between all the island countries in the Caribbean regions, fostering a network that continually strengthens. This will be complemented by the creation of a web page that will contain educational resources, news and activities relevant to the objectives of this initiative, information on national nodes, how to join this initiative, etc.

CAI initiative is actively working on the development of materials for educational purposes, in some cases these materials can be used in early education, elementary aspect and it can be adapted for high school and Undergraduate education aspects.

4.1. *An Accesible Book of Astronomy*

The students from the University of the West Indies are assisting in the process of writing an accessible Astronomy book authored by Dr. Wanda Diaz Merced. This book explains the concepts of physics, mathematics, and Astronomy in an multi-sensorial way, preserving the complexity of the scientific content at undergraduate stages of learning. For instance, some of the topics of the book are related to stars, stellar evolution, black holes, pulsars, etc. Careful attention is paid to create text and examples that are neutral in sensorial perception, identities and usage of mathematical formulas using words and graphemic expressions (mathematical symbols).

4.2. *LightSound*

We are working with an instrument called LightSound (Bieryla et al. 2020). It was designed by astronomer Allyson Bieryla and collaborators at Harvard University as a tool originally created for the blind and visually impaired community to experience the solar eclipse of 2017 by converting light to sound. The LightSound was also used during the South American solar eclipses in 2019 and 2020.

It has an incredible potential to be used as a tool for teaching Astronomy concepts in a classroom or outreach setting. The project is open source with

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Fig. 2. This image shows a LightSound being built by the team in the Dominican Republic. In the image one can see the open chassis with the wires, battery and circuits.

Fig. 3. This figure shows an Orchestar demo, using a light and 3 color filters - blue, green and red. The Orchestar is attached to a speaker to demonstrate the changing sound with color.

documentation and software available to download. LightSound can run on a battery or be powered by a computer. If connected to a computer, the computer can record the data for future sonification or analysis, and the device also has an audio jack where headphones or speakers can be used to hear the real-time sonification.

This instrument is in the process of being built in Trinidad and Tobago. It was already built in the Dominican Republic (see Fig. 2 for an example of the LightSound in the Dominican Republic), where now they are in the process of creating lessons using the Lightsound. As an example, it is planned to be used, as an instrument to understand the motions of the Sun in the sky (by tracking the shadows), to use it as a tool to calculate the angles of elevation of the Sun, in order to determine the local noon and thereby determine an accessible path of the Sun through the zenith. This lesson has already been successfully performed in South Africa by Dr. Wanda Díaz Merced, where the LightSound was used to follow the motion of the Sun using the shadow from a tree.

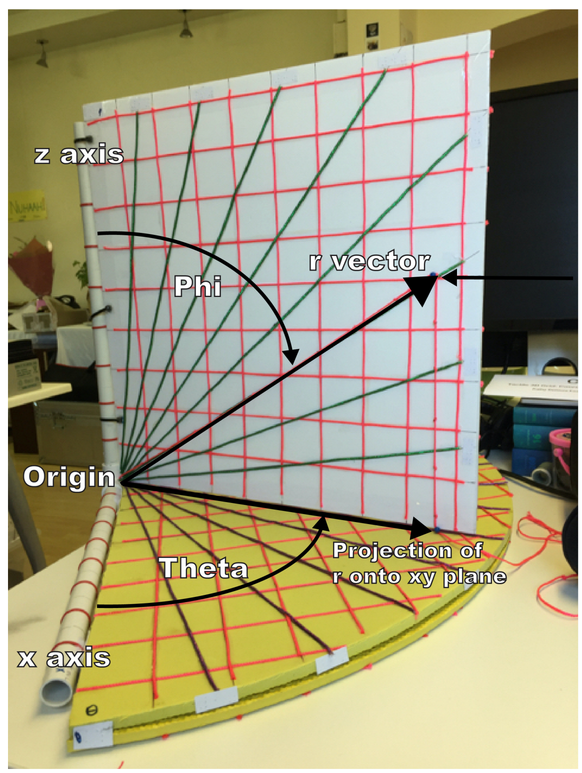

Fig. 4. The CARDIS, Coordinates and Relative Dimension in Space (http://cardis.nau.edu).

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Fig. 5. This is an example of a setup in which the telescope is being aligned with a tactile protractor for declination and CARDIS for RA.

4.3. *Orchestar*

We are also working with another instrument called Orchestar (Fig. 3 found at http://astrolab.fas.harvard.edu/orchestar.html) that was also designed by Bieryla and collaborators at Harvard University. It is a sonification device that converts light into sound based on color. It has been used in Puerto Rico by blind individuals who are able to manually align the telescope to find and listen to the Moon, allowing them to acquire data. It has also been used to teach important Astronomy concepts about light and the color and temperature of stars.

4.4. *CARDIS*

The CARDIS (Fig.-4, found at http://cardis.nau.edu, (Eastwood 2021)), which stands for Coordinates and Relative Dimension in Space, is a three-dimensional tactile grid that helps visually impaired learners. Designed by Dr. Kathy DeGioia Eastwood and Dr. Wanda Díaz Merced, this is a low-tech tool that can be built with simple materials, making it accessible to a wide range of students. It can be used in elementary and middle schools to introduce concepts of area and volume. It can also be used with high-school and university students to introduce the concepts of conversion between Cartesian and spherical coordinates. Used as a part of an Astronomy lesson, it can help visually impaired learners with the relative location of objects. On Fig. 5 we can see and example of the CARDIS and a tactile protractor being used to find a given RA and DEC.

The CARDIS has been made available in Trinidad and Tobago, Haiti and Dominican Republic, and the next step is to work with the teachers so that they can incorporate its use with their students. Using the scheme of free postal access for the blind and physically handicapped it has been delivered at no cost to those countries.

4.5. *Scale Models*

An example of the activities designed for elementary school includes the creation of a Solar System on a rope. When discussing the concept of scales, we choose a scale for the distance between the Sun and the Earth, then the students themselves build their own model. The scale used here is the size of their index finger. Because people are familiar with their own body, the understanding of the dimensions of the Solar System becomes more tangible. Based on this scale we adjust the rest of the distances and the students create their own Solar System on a rope. Of course, once built, we travel through his model of the Solar System. When fully accessible, we will discuss ideas about sounds and data sonification that can be further implemented for the distance modeling of the Sun and the planets.

A similar activity has been designed for the Earth-Moon system where, again, we use our own body to create a personalized scale. We use our fist for representing the size of the Earth and our thumb for the Moon. When students have a tangible perception of the size and the distance between the Earth and Moon, and are using their own body to understand these concepts, the knowledge becomes more real, familiar and palpable.

5. SIGN LANGUAGE FOR ASTRONOMY

From the International Astronomical Union (IAU), there has been an effort to collect a comparative list of astronomical signs in each country. This list has about 100 signs. According to the official Sign Language dictionary of the Consejo Nacional de Discapacidad (CONADIS 2021), in the Dominican Republic we only have 8 recognized signs. Sign languages are of a high national variability, even depending on the root from which they derive within the same cultural region (for example, the language of the Dominican Republic, Peru, Costa Rica or Bolivia have the American Sign Language as their root). (ASL); while the sign language of Spain derives from the French sign language, while the languages of Venezuela, Argentina or Chile derive, in turn, from that of Spain). The situation is even more complex in the English-speaking Caribbean where the creole language spoken is historically influenced by the culture of the colonizers and as such there is no direct influence one can trace. For example, in Trinidad and Tobago, the history of the origin of Trinidad and Tobago Sign Language (TTSL) is not clear as to whether it is its own origin, or started with BSL (British Sign Language) or the more recent influence of ASL (Braithwaite 2018). There is a generalized Caribbean sign language (CSL) that is considered to be mutually understandable among the English-speaking Caribbean with its nuances based on the islands (for example, JSL for Jamaica).The non-existence of words within the different sign languages of the region is severely serious since it not only prevents the description of astronomical reality, but also prevents the possibility of learning about it. This, given the aforementioned interdisciplinary nature of Astronomy, is also applicable to the impossibility of describing and understanding the world from a scientific point of view, a situation that further isolates this group of people, as is currently the case with the COVID-19 health crisis and the measures that have been taken to face it. Thus, Astronomy is not accessible to the deaf community, and there must be changes in order to make Astronomy accessible. It is for this reason that CAI is searching to develop, together with the deaf community, signs and translations of the local sign language alongside with all the public talks on the topic of Astronomy.

6. THE UNITED NATIONS GOALS FOR SUSTAINABILITY

Finally, we are working hand-on-hand with the sustainable development goals of the United Nations. This means that CAI wants to ensure successful transition and immersion into the work field, accessible, equitable and quality of education and to promote lifelong learning opportunity for all.

This is specifically related to goal number 4, quality of education, which translate to goal number 8, decent work and economic growth, and number 10, because this will reduce inequalities.

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