

STEM education in semi-virtual interactive environment

Educación STEM en ambiente interactivo semi-virtual

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Keywords

STEM education; Costa Rica; semi-virtual environment; Covid-19; humanitarian project; STEM workshops; volunteering.

Abstract

The Covid-19 pandemic has forced us to change the way we used to handle education in our homes, through sanitary restrictions that seek to prohibit or reduce physical contact, moving from the traditional way to a virtual methodology; reason for which we must look for new solutions to adapt to this new teaching strategy. In addition, the pandemic has accelerated the arrival of the 4.0 revolution or technological revolution, where new challenges arise for society. The above reasons serve to justify and encourage that STEM education cannot stop. However, given the crisis we are experiencing and the solutions provided, the excessive use of virtual environments can affect areas such as psychological, social, etc. Through this project, a learning model implemented through volunteers is proposed, based on an interactive semi-virtual environment, where the participant can interact synchronously with a volunteering model provided by the volunteer tutor, and the learning process is supported through workshops and the use of virtual tools.

Palabras clave

Educación STEM; Costa Rica; Entorno semi-virtual; Covid-19; proyecto humanitario; talleres STEM; voluntariado.

Resumen

La pandemia del Covid-19 nos ha forzado a cambiar la manera en que solíamos manejar la educación en nuestros hogares, por medio de restricciones sanitarias que buscan prohibir o reducir el contacto físico, moviéndonos de la forma tradicional a una metodología virtual; motivo por el cual debemos buscar nuevas soluciones para adaptarnos a esta nueva estrategia de enseñanza. Además, la pandemia ha acelerado la llegada de la revolución 4.0 o revolución tecnológica, en donde surgen nuevos desafíos para la sociedad. Los motivos anteriores sirven para justificar y fomentar que la educación en áreas STEM no puede detenerse. Sin embargo, ante la crisis que vivimos y las soluciones provistas, el uso excesivo de entornos virtuales puede llegar a afectar en áreas como la psicológica, social, etc. Por medio de este proyecto se plantea un modelo de aprendizaje implementado por medio de voluntarios, basado en un ambiente semi-virtual interactivo, donde el participante pueda interactuar sincrónicamente con el tutor, y el proceso de aprendizaje sea apoyado por medio de talleres y el uso de herramientas virtuales.

Introduction

Many of the 21-century global challenges, including climate change, poverty, health, education, affordable and clean energy, economy, the care and management of the resources that impact the country and the world, are addressed for the 2030 Agenda for Sustainable Development as the 17 Sustainable Development Goals (SDGs) [1]; these challenges urge a transformation in our society, will require support and development of skills such as problem-solving in science and technology for the management of such challenges through a quality STEM Education.

From the challenges mentioned before, the prompting of STEM education stands out, since it is an area of global interest in which many governments from different countries have been involved, some of them to promote it from the early ages of their children, and others making

spaces for people to get involved. The main reason is because of the impact that these careers have on the development of the country and the possibility that they contribute to a reduction in the social gap main challenges that have been noted through the years.

Despite the aforementioned, it is known that not everyone has equal opportunities in access to knowledge in this area, and due to the pandemic, the social gap that we knew about has increased. Therefore, we propose a volunteer model where volunteers with knowledge on the subject can encourage their development from organizations such as IEEE humanitarian groups, through a program in a semi-virtual environment that strengthens education and communication, helps the mental health of students, and brings back the feeling of closeness that existed before the isolation measures imposed by the authorities.

State of the art

STEM Education

What is STEM Education, what does it mean? This is an educational trend that emerged at the beginning of the 21st century in the United States, which response to the fields and competencies most in-demand in the industry today, in addition, it is an acronym that integrates four discrete disciplines; including Science, Technology, Engineering, and Mathematics; in an interdisciplinary approach to develop collaboration skills, creativity, critical thinking, communication, problem-solving, among others. This term includes all the fields mentioned before, and according to [2], a STEM education motivates the students to increase and develop skills and applied those to an understanding approach of the usage of science, technologies, and engineering that involves problem-solving and innovation for our daily life global challenges, finally, it intends to have an impact on advanced research and development focused on innovation.

Costa Rica: Education and Work during the pandemic

With the arrival of the Covid-19 pandemic in Costa Rica, the educational system was affected and was even paused while a strategy was being generated to allow the resumption of a training cycle adapted to the measures imposed by the health agency [3]. Among the strategies used by the different entities, “Aprendo en Casa” was implemented by the Ministry of Education, which intended (through television classes and guides for students) to continue the educational progress of children and youth [4]. Another case was found in the public universities, which managed to resume classes virtually, even seeking to provide technical facilities to some students who needed it to continue [5].

Despite the efforts made, on August 28, 2020, it was reported through a press conference that around 91,000 students from schools and colleges had stopped studying through the means made available to them; which represents a dropout rate of around 8.5% of the entire enrolled student population registered at the beginning of the year [6].

Virtual environments in education

The impact of the 4.0 industrial revolution in America was influenced to a great extent by the pandemic, producing an “exponential” growth not foreseen in the implementation of virtual environments for different purposes, modifying paradigms for which we highlight the area of education, wherein most countries have had to go from a face-to-face environment to a virtual one.

Even though in this environment some many advantages and opportunities can be exploited to generate highly productive environments to compete with traditional spaces; One cannot lose sight of some negative factors such as the absence of computer equipment and the

discrimination that this can cause in education. The change requires the greater dedication of professionals to adapt their material and basic knowledge of the tools to be used. The absence of elements such as those mentioned, can cause the orientation of the technology in itself and not in the proposed learning objectives; a fact that can be considered a disadvantage compared to the traditional teaching style [7]. According to the authors of [8] in the work about the influence of the smartphone in the learning and teaching processes, it stands out how its results showed negative consequences derived from excessive use of the intelligent device, can have psychological, academic, and social repercussions, cyberbullying, abstraction of reality, a saturation of information, loss of sense of reality, among others.

Constructivism

The definition of constructivism varies according to the perspective and position, but it is usually generalized as the capacity to learn and understand reality in a personal, subjective way, related to the socio-environmental context in which each individual is formed [7]. In the educational field, according to [9], this concept is related to the result of the learner's experience and interaction with the world, a process that seeks the application of a methodology that allows the person to learn how to learn on his or her own; based on the analysis of one's own experiences and assuming representation, selection and self-direction capabilities.

Volunteering

Volunteering from the neurological view [11], depends on two things, first the motivation which can be explained as a process in which someone wants something (that they feel is attainable) and works towards that goal, to ultimately obtain satisfaction; and empathy understood as a person's ability to sympathize with someone's problems or necessities. Those two facts lead us to define volunteering as a human decision to generate satisfaction by working on someone else's cause, which is validated by the parietal lobe so that later, without falling into a bias, it is validated by the frontal lobe. Activating motivation and generating empathy for the person with the cause [12].

Some benefits of volunteering, specifically in an online system, are that volunteers can make the most out of the time they are giving to the cause, it reduces the amount of time traveling, and finally involves everyone from children to elderly, including people with disabilities or part of groups with disadvantages. (<http://jhr.ssu.ac.ir/article-1-479-en.html>)

In volunteering we've found the perfect environment to develop and impart courses for people of different ages and levels of knowledge, closing the social gaps created by a society where access to education is limited to people with better resources and those which are close to big cities (see figure 2).



Figure 1. STEM activity at the rural high school Gavilán Vesta in the indigenous Cabécar-Tayní community in Valle de la Estrella, Limón, Costa Rica.

Methodology

In the present project, we propose to develop exercises and workshops to be imparted in a semi-virtual environment, where the participants can learn through interactive workshop units and synchronous activities, where participants have access to the material provided. Those are implemented throughout a volunteer model, in which students can contribute and participate out of the conviction of wanting and helping others, carrying out good deeds, and sharing knowledge and experience with the youngest generations [10].

This project aims to train trainers and during that process generate the necessary tools and information that are most suitable to establish a teaching methodology that can be replicated in a large number of educational centers, including those with budget limitations and the equipment available to work on the topics required to achieve good learning and understanding of STEM topics. In these activities, the use of educational kits is proposed, for example, Snap Circuits (<https://www.elenco.com/brand/snap-circuits>), Arduino (<https://www.arduino.cc/>), Raspberry (<https://www.raspberrypi.org/>) and other materials that allow interactive learning “based on the constructivism pedagogy”.

Creative, interactive, and intuitive teaching-learning methodological processes can enhance the capacity of girls and boys, in sociocultural and educational contexts with a low human development index to introduce STEM and help to improve their quality of life in the future.



Figure 2. Volunteers from IEEE Student Branch at TEC Costa Rica.

The main purpose is to generate educational material after a series of dictated online workshops to be followed by participants at their own homes or schools, to determine later the best methods to be used. Part of the benefits is that in the future these materials can be available to share with others in more locations, even countries.

Looking to work with other teachers and professionals as volunteers and NGOs. The project will be implemented in different places of the country, especially in rural areas, with potentially hundreds of people (kids, young, teachers, and more), looking also to have equal gender participation.

Workshops

Workshop general content

Here an overall explanation of how each virtual workshop will be structured is given to provide the best learning experience possible for the ones attending it. Here is also explained some samples of activity and its duration, so that the extension of those is not exhausting to the attendees. The program consists of a one-week hands-on STEM methodology through workshops.

Workshop section	Description	Duration
Introduction	We introduce the participants to the STEM project and workshops that will be taught. The workshop speakers will start a brainstorm with the participants to explain the STEM concept through interactive activities to promote participation.	20 minutes
Theory explanation	Speakers introduce the formal concepts of the subject and give theoretical examples to reinforce the concepts explained and developed through the session involving the constructivist paradigm.	20 minutes

Workshop section	Description	Duration
Hands-on practice and theory reinforcement	Participants are instructed to use a specific tool to follow the example given and then encouraged to explore within the set of characteristics and functions available so that the concepts explained before can have a better impact on them.	40 minutes
Conclusions	With the new knowledge acquired, we evaluate through an exercise the projects developed by the participants, where they will present their knowledge and how this can benefit or help in building a better society in STEM areas.	30 min

Workshops description

In the following section, we describe the workshops develop by volunteering community.

Workshop name	Description
Introduction to computer programming	The main goal of this workshop is to remove fear about computer programming from the participants, using the Python programming language. Introduce basic concepts and explain how computer programming can help to build and develop solutions, promoting the development of creativity, logic, and problem-solving.
How to build my first mobile application?	This workshop's objective is to give an overall tour of how to build a mobile application with the free visual tools available on the web. In addition, it is not intended to be specific on the instrument, but to explain the main ideas that make most of these work the way they do, so it is easier to switch from a tool to another one that works under the same concepts.
Linux as an Operating System alternative	Windows has come to be one of the main user-oriented operating systems, and so one of the most used. But what about a free alternative to it? In this workshop, some Linux history will be explained and attendees will be submerged under a new experience in a new Operating System.
Get to know college!	People have negative and different perceptions about universities, which the objective of this workshop is through university volunteers to share experiences they have had in the university with the participants, dealing points such as challenges, motivations, expectations for the future.
Hands-on inside the circuits world	Arduino and Snap Circuit is an open-source electronics prototyping platform that allows users to create interactive electronic objects. In this session, we introduce concepts, basic components, basic exercises to the participants so they can get their hands dirty in the world of electronics, without having the fear of burning an LED or getting electrocuted, and expose how you can develop modular projects that can be part of a more complex project for a complex solution.


Future work


With the advance of digitalization, the information and communication technologies have brought us benefits from different aspects in our society, but this has not been the same in all people, creating the digital gap, which has been growing with the advance of technology. And this has been a challenge for the actual society that needs to be taken into account.

Through this project, the main goal is to generate educational material and new semi-virtual environment interaction workshops to be followed by participants and encouraged by volunteers at their own homes or schools, so in the future these materials can be available to share with others in more locations, even more countries.


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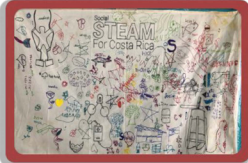





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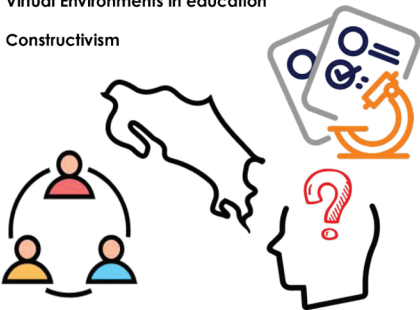
Introduction

The Covid-19 pandemic is forcing us to change the way we handle education at home, due to sanitary restrictions that prohibit or reduce physical contact, carrying us from the traditional way to a virtual methodology; reason why we must look for new solutions to adapt to this new teaching strategy.

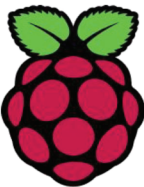

Background



- ◆ STEM Education
- ◆ Costa Rica Education and Work Challenges in pandemic
- ◆ Virtual Environments in education
- ◆ Constructivism

Methods


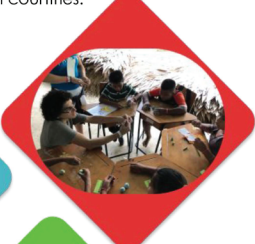
- ◆ Develop exercises and workshops to be imparted in a semi-virtual environment where the participants can learn through synchronous and asynchronous activities.
- ◆ Implemented using a volunteer model.









Next Steps

Generate educational material for workshops to be followed by participants at their own homes or schools, so in the future these materials can be available to share with others in more locations, even countries.



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Illustration 1. Presented Poster at LAEDC 2021.