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STEM/STEAM learning model. Case study: let's go seminar! Discover yourself in science

Modelo de aprendizaje STEM/STEAM. Estudio de caso: seminario ¡vamos! Descúbrete en la ciencia

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Abstract

Resumen

Early science vocations, STEAM, High school, Science camp

Vocaciones científicas tempranas, STEAM, Preparatoria, Campamento científico

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Introduction

The project "Seminar for the promotion of scientific vocations, let's go! discover yourself in science", born in 2019, was designed by a group of researchers from different areas of the national scientific community to promote scientific and technological development in the State of Nayarit, having in its 2020 - 2021 stage, as main objective "to encourage scientific vocation in young high school students of the UAN through the scientific approach to five areas of knowledge", to awaken interest in science in a practical way through three strategies: (a) discussions carried out directly in their localities, (b) practical workshops on science and technology with national researchers, (c) science camp and (d) project fair, with the aim of promoting science as a career option for young people in the state.

This advocacy project is based on the idea of the STEM (Science, Technology, Engineering and Mathematics) learning model for the promotion of scientific vocations.

Background

The United Nations Educational, Scientific and Cultural Organisation (UNESCO) Conference on Science for the 21st Century established in the Budapest Declaration that: For a country to be in a position to meet the fundamental needs of its population, science and technology education is a cross-cutting strategy. As part of such science and technology education, students should learn to solve concrete problems and meet the needs of society by using their scientific and technological knowledge and skills (UNESCO, 1999).

According to ANUIES (2021), the number of professionals dedicated to science, technology, engineering and mathematics (STEM) is very low, in proportion to the existing demand in Latin American countries.

This is why the member countries of the United Nations (UN), through the 2030 Agenda and the Sustainable Development Goals (SDGs), specifically the fourth SDG on quality education, the fifth on gender equality and the ninth on industry, innovation and infrastructure, serve as a framework for the development of the STEM model, serve as a framework for the development of the learning model that has been called STEM or in its version that includes the STEAM arts, as a tool to encourage the enrolment of new talents in these areas of knowledge in order to influence the development of countries with poor and marginalised populations such as Mexico.

To make Mexico a more competitive knowledge society, it is necessary to promote an increase in the number of men and women dedicated to science and technology. Science is the essential tool that a country must have, and it is therefore essential to train citizens with greater STEAM skills in the creation of knowledge, technology and innovation to face national and global challenges such as climate change, famine, new pandemics and the continuous advance of the digital era.

Promoting scientific vocation in young people contributes to the growth of scientific knowledge, which will have an impact on economic growth, social equality, political decision-making based on facts, greater transparency and the strengthening of professional ethics, mainly scientific knowledge that is the axis for the human development of the population, which promotes social welfare, gender equality and respect for the environment (Unesco, 2016).

Therefore, the Seminar aims to train young people in science with a human approach, concerned with the search for direct solutions to national problems that limit the country's development. This is under an approach of young researchers trained in science thinking with social impact (Chamber of Deputies, 2021).

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The STEM/STEAM model contributes or develops the following capacities: a) the practical, b) the civic-democratic, c) the cultural and d) the economic; considering that these capacities allow people to make the best decisions, solve the small and complicated problems of everyday life, that is, to understand, comprehend and inhabit the world in which they live (Perelejo M.; 2018).

The complexity of the changing world requires an inter and transdisciplinary training between science, innovation, entrepreneurship, arts that facilitates access to the labour market, as well as breaking the idea of traditional education (classroom by virtual, flexible), it is necessary to learn in the field, in the company, consider informal learning among others; transcend local, regional, national and international borders to influence the largest number of people with scientific knowledge. Therefore, through the STEM/STEAM Model, the aim is to teach through science: to think and understand the world we live in, without excluding anyone, this is the principle of inclusion and local recognition. An education that gives space to search, to learn with others and from others, principles that were taken up as the main ideas in the Seminar on Promoting scientific vocations in the discussions, workshops and formulation of regional scientific projects.

With the actions promoted by international organisations and the visibility of the lack of human capital with STEM/STEAM skills in our country, since the year 2000 different actions have been developed that seek to promote science among young people, to encourage scientific vocations, with the gender perspective as a cross-cutting theme, with the aim of closing the existing gap between gender participation in the different scientific, academic, technological and innovation fields (OECD; 2021).

In the STEAM model, teacher participation is of utmost importance, in their role as trainers, teachers should promote inter-, multi- and transdisciplinarity in their teaching processes and a management of Information and Communication Technologies (ICT), which integrates STEAM learning.

That is, "science education should promote opportunities to immerse and revive thinking and reflection, to benefit from the adventure of enquiry, from the desire to learn and to continue learning" (Macedo 2016, p.12). For this reason, the participation of teachers at the upper secondary level is fundamental for the promotion of scientific vocations; therefore, the Seminar established as a strategy the participation and training of teachers as binding agents to promote scientific vocations.

Methodological process

This research is based on a methodology of interpretative phenomenological analysis, by means of which the experience lived by UAN's upper secondary school students was examined in depth with respect to their participation in the different events that were held in 2021 through the project "Seminar for the promotion of scientific vocations, Let's go! discover yourself in science", for which tools were used such as: interviews with open and exploratory questions, work logs, satisfaction survey, photographs and messages (WhatsApp, Facebook and email) in which the meanings constructed about this experience were poured. This allowed us to know in detail the descriptions that the participants made of their experience.

The sample selection design is non-probabilistic in its mode of purposive sampling, which, according to Miles, Huberman, and Saldaña (2013) the people who will be intentionally and deliberately selected can provide a rich and deep understanding of the problem under study. For this reason, only young people who participated and experienced at least one of the events that were held were included in the study, with the intention that the questions that were developed would be meaningful and sensitive.

Actions and strategies for educational advocacy/intervention

The scientific vocation is the result of the interest and capacities that students generate from early stages, according to Vásquez A. (2009) focuses on four items that should be promoted in young people to ensure their interest in opting for scientific life. From this Seminar, we add the capacities of young people to innovate (Figure 1).

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These items are the vocational capacities that were fostered in the students who participated in the seminar and were established in each intervention strategy of the project to ensure the promotion of the scientific vocation. These five items are only a first approach to encourage, discover and enhance the interest and skills of young people to develop professionally in science.

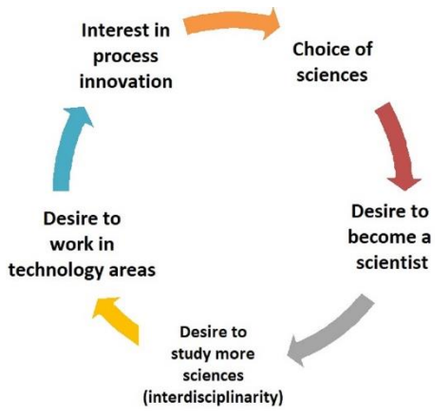

Figure 1 Items for fostering early scientific vocations from the Seminar: Come on, discover yourself in science!
Source: Vásquez A. (2009) and own data

The objective of the "Come on, discover yourself in science" seminar is to promote scientific and technological development in the state of Nayarit by encouraging scientific vocation among young people in the 15 high schools of the Autonomous University of Nayarit, as an option for a professional life that will allow young people to achieve social mobility.

The seminar "Come on, discover yourself in science" is the result of the interest of a multidisciplinary group of researchers from different areas of knowledge, from the National System of Researchers, CONACYT professors from more than 13 recognised institutions in the country and a group of researchers from the Autonomous University of Nayarit, who upon observing the living conditions of young people in the state, joined forces to jointly formulate actions to promote early scientific vocations as a development option for young people and society in Nayarit. This is made up of four strategies and concrete actions to guarantee the fulfilment of the objective:

A) Cycle of talks "science a life choice":

These were held in the high school facilities, which guaranteed the inclusion of the student population of the UAN's upper secondary system throughout the state of Nayarit. Scientists were brought closer to the space and environment of the students, which allowed for greater participation and the care of the sanitary protocol required by the COVID19. 8 talks and workshops were presented in person in the areas of knowledge, given by researchers from the different participating institutions in the country. The purpose of the talks was to encourage students' interest in science and technology in the different areas of knowledge. Scientists from the areas of Health Sciences, Physics-Mathematics, Biological-Agriculture, Social Sciences and Humanities were invited to interact with the students through informal talks about their areas of training, visiting foreign high schools such as Villa Hidalgo, Ixtlán, Ahuacatlán, and those in the capital city.

Figure 2 Health sciences discussion in high school No. 9. Villa Hidalgo
Source: Seminar on the Promotion of Scientific Vocations (2020)

B) Science Camp "Go! Discover yourself in science"

With theoretical-practical workshops in the 5 areas of knowledge with the participation of selected students, 15 upper secondary level teachers and a researcher recognised by the scientific community for each area of knowledge. Plus the implementation of two multidisciplinary workshops: a) Gender mainstreaming in science; b) Innovation and regional sustainable development.

More than 400 interested students registered and were asked to answer a questionnaire of skills and aptitudes, which was used to identify and select 65 students from the 15 high schools of the UAN by stratified random sampling.

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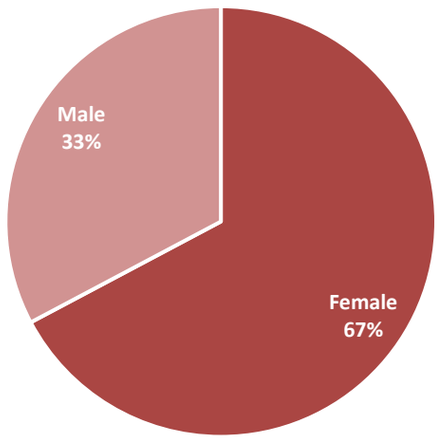
Figure 3 Workshops in the area of humanities: science in music and in the area of physics-mathematics: principles of photonics
Source: Seminar for the promotion of scientific vocations (2021)

The camp lasted 5 days and was attended by 39 female and 19 male and 19 female students, distributed in the spaces set aside for the development of the workshops, in which the activities programmed by the invited researchers were carried out.

As an elementary part of the Seminar for the Promotion of Scientific Vocations, Come on, discover yourself in science, each of the scientific workshops was developed in detail under the STEAM method and liberating education, with a selection of topics according to the interest and knowledge of the participating students. Each workshop was designed by scientists recognised in the national scientific community, where they selected and addressed topics in line with their lines of research. The workshops in each area were validated at the Science Camp in order to measure their feasibility, impact and appropriation of knowledge by the participating students, with the aim of becoming the strategic axis for the promotion of scientific vocations.



Graphic 1 Gender distribution of students attending the camp
Source: Own elaboration

C) Science fair "Discover yourself in science".

The students presented project ideas and results for the benefit of scientific, technological and innovation development for the State of Nayarit, as part of the result of the work carried out in the Camp workshops. The best projects were awarded with a Tablet.

Figure 4 Young people awarded for their project ideas presented at the Fair
Source: Seminar on the promotion of scientific vocations (2021)

Training of science vocation promoters

In the camp, a training course for the promotion of scientific vocations was started for 17 upper secondary level teachers, who accompanied the students, with the aim of training agents in the promotion of early scientific vocations, for the implementation of programmes, strategies, projects and activities for the promotion of scientific culture, dissemination and transfer of scientific knowledge and management of projects focused on the promotion of scientific vocations in young people at the upper secondary level.

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General results

Students with high interest to continue in the process of training in early scientific vocation were identified:

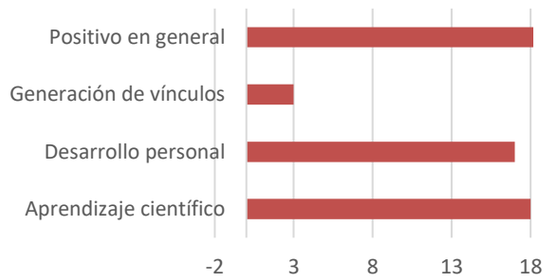
- 15 students with high scientific interest.
- 60 students for follow-up and continuous training.
- 19 upper secondary level teachers for accompaniment and training as liaisons for the promotion of early vocations.
- A method of selection of students with an interest in scientific vocation was designed, with a specific selection instrument related to the objectives of the project.
- A database of pupils interested in participating in science education activities.
- A selected group of pupils identified as having outstanding ranges of interest and aptitude in science.
- Design of a guide with didactic programmes for the promotion of early scientific vocations for the UAN with a focus on gender and inclusion of vulnerable groups.
- It was considered as a cross-cutting strategy of the project that at least 50% of the participating population should be women, as an initiative to influence the reduction of the gender gap in science. This challenge was overcome due to the high level of interest in participation of female students and teachers at the upper secondary level, with 65% of the participants being female.

One of the objectives of the seminar was to establish a longitudinal follow-up system to accompany and monitor the 15 selected young people with an interest in science in order to strengthen their scientific vocation and their incorporation into the research summers.

At the end of the camp, the participating students were asked to answer a form in order to assess their perception in relation to: general experience, social interaction, organisation and equipment, scientific learning and personal development.

In each of the dimensions assessed, more than 95% of the answers were reported as Good and Very Good, so that, according to the students' perception, the camp promoted interaction, scientific learning and personal development, as well as a good organisation that resulted in a very good experience for them to continue their education in science.

The total number of students who attended the camp were asked: "What did the seminar mean to you for the promotion of scientific vocations, come on, discover yourself in science? What do you leave with?", to which 34% responded that it was a positive experience in general; 31% considered it a scientific learning experience; 29% considered it a personal development; while 5% perceived that the camp meant a generation of links for them.



Graphic 2 Students' perceptions of the camp experience
Source: Own elaboration

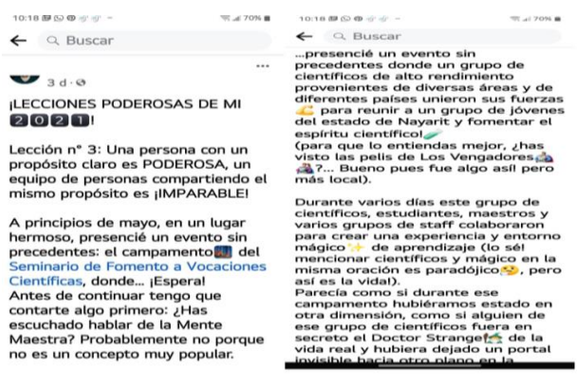


Figure 5 Perception of the Seminar's events through personal messages
Source:
https://m.facebook.com/story.php?story_fbid=4660255114092629&id=100003245590256

The pandemic situation limited to a great extent the actions and contribution of a greater number of students who were interested in participating more vividly in each of the activities, this allowed to evaluate and make visible the interest of these, as well as the teachers of each high school to motivate early vocations in each population. This encourages the team of the scientific community that supports the Seminar to continue with its activities and initiatives, in search of giving alternatives to the most vulnerable young people in the State of Nayarit.

Conclusions

Outlining actions for the promotion of early scientific vocations is a strategy to provide young people with scientific tools that will allow them to face the diverse global and national problems under a holistic formation, to encourage critical thinking and education as a practice of freedom; the defence of science education as a dialogical act; the problematisation and interdisciplinarity of the educational act and the notion of a science open to popular needs.

It is important to use inter-, multi- and multi-disciplinary strategies in the education of young researchers in order to train scientists with critical thinking who are close to society and its diverse problems in a practical and critical way. It is a priority to include in education systems the vision of fostering scientific vocations in order to build inquiring minds in young people, with critical thinking about their social, economic and environmental surroundings, elements that are fundamental and that should characterise today's scientists. For this reason, it is essential to encourage scientific vocation from an early age, where the construction of thought is formed from the environment.

To create a scientific vocation in young people will contribute to the growth of scientific knowledge, which will have repercussions on economic growth, social equality, political decision making based on facts, greater transparency and the strengthening of professional ethics, mainly scientific knowledge that is the axis for the human development of the population, which promotes social welfare, gender equality and respect for the environment in Mexico and especially in the state of Nayarit.

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