

Quantitative analysis of the incorporation of undergraduate students to scientific work in a public university in Jalisco

Análisis cuantitativo de la incorporación de estudiantes de pregrado a la labor científica en una universidad pública en Jalisco

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Abstract

Generating interest in undergraduate students, with their participation in science for scientific development, which affects the main problems that human beings face, is a primary task for both universities, government and society. Therefore, the objectives of this article are focused on analyzing the participation of undergraduate students in the development and implementation of scientific research projects, based on their academic training, as well as the dissemination of their findings and the staging of problems of the state of Jalisco, with practical solutions, within the Multidisciplinary Program for the Development of Modular Projects (PMDPM). In this sense, a quantitative analysis of the participation of 809 undergraduate students incorporated into the PMDPM was carried out, regarding the development of scientific projects, scientific dissemination in congresses, the publication of scientific papers and the development of theatrical works from 2014 to 2020. The notable results are: 138 modular projects, 60 scientific disclosures in national and international congresses and 5 papers published in peer-reviewed and indexed journals, and the creation of the Spontaneous Reaction theater group.

Project-based learning, Early research, Popular science

Resumen

Generar interés en los estudiantes de pregrado, con su participación en la ciencia para el desarrollo científico, que incida en las principales problemáticas a las cuales se enfrenta el ser humano, es tarea primordial tanto para las universidades, el gobierno como para la sociedad. Por ello, los objetivos del presente artículo se enfocan en analizar la participación de los estudiantes de pregrado en el desarrollo e implementación de proyectos de investigación científica, basados en su formación académica, así como la divulgación de sus hallazgos y la puesta en escena de problemáticas sociales del estado de Jalisco, con soluciones prácticas, dentro del Programa Multidisciplinario para el Desarrollo de Proyectos Modulares (PMDPM). En este sentido, se efectuó un análisis cuantitativo de la participación de 809 estudiantes de pregrado incorporados al PMDPM, respecto al desarrollo de proyectos científicos, la divulgación científica en congresos, la publicación de los artículos científicos y el desarrollo de obras teatrales del 2014 al 2020. Los resultados destacables son: 138 proyectos modulares, 60 divulgaciones científicas en congresos nacionales e internacionales y 5 artículos publicados en revistas arbitradas e indexadas, y la conformación del grupo de teatro Reacción Espontánea.

Aprendizaje basado en proyectos, investigación temprana, Divulgación científica

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1. Introduction

At present, the National Council of Science and Technology (CONACYT) is the main one in charge of promoting the development of scientific research in Mexico, as well as technological development and innovation, which is recognized through the granting of distinctions to the researchers in different categories. However, the public university, as an institution committed to academic excellence, social solidarity and humanistic thinking for the sustainable development of the entity, as well as the contribution to the economic development and social welfare of the regions of Jalisco (Universidad de Guadalajara [UDG], 2018; Universidad de Guadalajara [UDG], 2019), is the main researcher trainer.

For this reason, it is essential to encourage undergraduate students to increasingly join in developing scientific research with an impact on society. In this same vein, the realization of a quantitative analysis, contemplating the achievements of the implementation of the Multidisciplinary Program for the Development of Modular Projects (PMDPM) of a public university in Jalisco, presents added value, because it reflects the reality of the incorporation of undergraduate students to early research, which allows decision-making for the establishment of new learning strategies and the promotion of science.

In concomitance with the above, the problem is formulated from the following question: What is the impact of the PMDPM on the participation of undergraduate students in a public university in Jalisco during the period from 2014 to 2020? For this, this research proposes to evaluate, through descriptive statistics and the document review technique, the number of students who participate, the number of projects they present, the number of disclosures in different conferences, the number of publications of scientific papers and electronic books, as well as the number of plays. That allows understanding the incorporation of students to the scientific field, with teaching-learning processes based on the development of projects.

The central hypothesis of this article proposes that, of 1,440 students enrolled in the careers of Chemical Engineering, Bachelor's Degree in Chemistry and Bachelor's Degree in Chemical Pharmaco Biologist (Centro Universitario de Ciencias Exactas e Ingenierías [CUCEI], 2020), upon joining the PMDPM they will achieve have an impact on scientific work with scientific products and performing arts. This is formulated as follows:

- H_0 : Of the undergraduate students enrolled in the careers of Chemical Engineering, Bachelor of Chemistry and Bachelor of Chemistry Pharmaco Biologist from a public university in Jalisco, less than 50% achieve an impact on scientific development, with academic production of modular projects, papers, publications in electronic books, dissemination in congresses and in the performing arts.
- H_a : Of the undergraduate students enrolled in the careers of Chemical Engineering, Bachelor of Chemistry and Bachelor of Chemistry Pharmaco Biologist from a public university in Jalisco, more than 50% achieve an impact on scientific development, with academic production of modular projects, papers, publications in electronic books, dissemination in congresses and in the performing arts.

This article is made up of 8 main sections. In section 1. Introduction, the subject under study is explained in a general way, as well as the importance, the technique to be used, the main hypothesis and the problem, as well as the generalities to be dealt with during the article. In section 2. Theoretical framework, it is possible to observe the theory of teaching-learning, project-based learning, modular projects, performing arts, description of the PMDPM, and implementation of the PMDPM. In section 3. Method, the type and design of the investigation, the description of the variables, the measuring instrument, the participants, the procedure and the data analysis are included. In section 4. Results and discussion, descriptive results and analysis against theory are detailed. In section 5. Annexes, the information collection matrix is shown.

In section 6. Acknowledgments, mention is made of the institution participating in the research. In section 7. Conclusions and recommendations, the main findings and future work are explained. In section 8. References, the authors are shown resulting from the review of the state of the art and with direct contribution to this study.

2. Theoretical framework

2.1 Teaching-learning

In the current knowledge society, there are many concepts that contribute to the teaching-learning process in Higher Education Institutions; aspects such as meaningful, autonomous learning; generic and specific competences; active methodologies; teach to think, and learn to learn; all this, to give way to a new paradigm, the model focused on learning, in which it establishes the student as a leading role, giving priority to their needs to promote knowledge throughout their academic training (Mertens, 2002; Murrieta, 2013).

In this model, the role of the teacher has been transformed, establishing basic characteristics to generate conducive learning environments, that is, one who fulfills the role of mediator or facilitator of learning and assumes a role of accompaniment with the students, through the implementation of active methodologies for the student to appropriate knowledge (Cerda, 2003; Maldonado, 2008). The learning-centered model has been a topic addressed by different organizations and authors, who from different positions and perspectives propose definitions in this regard (López, 2013).

The postulates of the World Declaration on Higher Education in the XXI Century: Vision and Action of the United Nations Organization for Science and Culture, establish that higher education has to adapt its structures and teaching methods to new needs (United Nations Educational, Scientific and Cultural Organization [UNESCO], 1998). One of the main characteristics of the new teaching model focuses on making the student the protagonist of the educational system. Learning is not reduced to the transmission of theoretical knowledge, but also to the development of general and specific skills and abilities (Roldan, 2000).

Therefore, the university has an important task that consists not only in training, but also in creating socialization spaces for young university students to approach a cultural and social plurality, for which it creates various activities including, participation in research programs (Hernández & Contreras, 2021). In this same context, the term educate, not only consists of imparting knowledge on topics to higher education students according to their study plan, but it is required to achieve a true meaningful learning in the students, after the qualitative improvement of this, by influencing the lives of students and consequently in society, in addition to allowing the construction of new knowledge contemplating research and teacher management, according to current scientific and technological progress (Yllescas, 2021).

With these new approaches, students generate greater capacities that allow better access to the labor market (Roldan, 2000), since the form of study will be more autonomous, reflective, multidisciplinary, cooperative and practical (Murrieta, 2013). Likewise, the hours of lectures are reduced and other more participatory formats are encouraged, such as seminars, debates or oral presentations, as well as autonomous study work. Although the teacher will continue to have a guiding function, the student will be required to give his opinion, solve, consult and put into practice what he has learned (Maldonado, 2008).

Due to the above, it is transcendental, the incorporation of curricular innovation, rethinking the way of innovating, contemplating the work of academics, their conditions and their possibilities to join these proactive processes (Zea, 2021). Therefore, some authors assure that it is necessary to leave behind the teacher-centered pedagogical model, since it minimizes learning, makes it rote and inconsequential (Gutiérrez, 2003; Cano, 2009).

2.2 Project-based learning

On the other hand, Project Based Learning (ABP or PBL, Project Based Learning) is a teaching model based on the use of authentic and realistic problems, directly related to the context of the profession, through which students develop skills with a collaborative approach in search of solutions (Blank & Harwell, 1997; Maldonado, 2008).

PBL has the potential to more effectively prepare students for future learning because it is based on four modern ideas about learning: constructive, self-directed, collaborative, and contextual (Dolmans, De Grave & Wolfhagen, 2005). Likewise, PBL is a learning model, through which students actively work, plan, implement and evaluate projects that have application in the real world beyond the classroom (Blank & Harwell, 1997; Bell, 2010; Martí, Heydrich, Rojas & Hernández, 2010).

In accordance with what has already been described, through the educational reform promoted by the H. General University Council of the public university in which this research is carried out, the pedagogy of projects is favored in order to develop competencies, abilities and skills of college students. That is why the new study plan for bachelor's degrees arises, which adopt a modular nature (UDG, 2019; CUCEI, 2020).

For this, the modules are defined as essential training nuclei that organize learning activities (courses, workshops, laboratories, seminars, etc.) around the domains of each professional field; that help to achieve the competencies established in the graduation profile (Universidad de Guadalajara [UDG], 2011; CUCEI, 2020), this allows undergraduate students to initiate scientific projects. To this are added, environmental projects, which are of great importance to minimize the negative impacts that man has caused on biodiversity and ecosystems, with the main objective of using natural resources in a rational way, being necessary the generation strategies in urban environments, as well as the implementation of teaching methodologies in this area for the identification of problems and solutions with the participation of students (Morales, 2021).

Therefore, young people are encouraged to be more proactive as promoters of sustainable alternatives, contemplating the development of their environment, their context, problems and needs, avoiding that students not only passively integrate into educational programs (Sánchez & Guerra, 2021).

2.3 Modular projects

Therefore, modular projects are activities that demonstrate the mastery of skills that university students acquire during their academic training. In this regard, students must develop a project for each module, to be evaluated by a specialized committee through the modalities of exhibition, prototypes, exams, reports and reports of professional practices, research and social service, among others. The modular project can be prepared individually or in groups and must be endorsed by the advice of specialist professors, in order to facilitate the development of projects (Universidad de Guadalajara [UDG], 2013; CUCEI, 2020).

Modular projects are an essential part to evaluate the transversal skills of application of knowledge linked to each of the modules. The purpose of carrying out projects is to contribute to developing the ability to take a problem from the complexity of reality, bring it to the field of its discipline and return a solution that acts in the scenario from which the problem was extracted (UDG, 2013).

In this way, it is possible to contribute to reversing the lag in science and technology, through the creation and innovation of new research projects that try to solve some of the problems in our environment, in addition to the fact that the student manages to develop skills with high potential that allows it to develop successfully.

Society changes and transforms itself, economic, scientific and technological growth become indicators that invite us to rethink education in the 21st century (Tedesco, 2003). Education in the 21st century is at a crossroads; On the one hand, it seeks to generate graduates to effectively join the world of work and, on the other, to train disciplined citizens to respond to the new relationships imposed by the knowledge society and to the skills demanded by the global economy (Touraine, 2005). Therefore, it is necessary to respond to the meaning of education in terms of: what, for what, how and where. These questions define an innovative proposal, which is consistent with the needs of the context (Sierra, 2016).

The planning and execution of modular projects should promote the development of transversal skills and competences of university students through innovative ideas based on the scientific method and the performing arts. Also, to contribute to the mission and vision of the public university, which establishes as a priority the comprehensive training of professionals who contribute to the development of sustainability, continuous improvement and social co-responsibility.

2.4 Performing arts

On the other hand, dramatization or the performing arts are an educational resource little used, especially at the higher level. It has great educational value, since many authors define it as an active tool that involves multidisciplinary approaches (Pérez, 2017). In addition, it is a motivating integrative instrument that educates in values and favors expression and communication in all fields of teaching, encourages different interpretations and integrates all kinds of intelligences.

The performing arts are also conceived as an appropriate element for personal and social knowledge and growth, since it is a way of communicating about a certain reality (Núñez & Navarro, 2007). For his part, Pérez-Aldeguer (2017), affirms that performing arts such as music, dance and theater can be used as a pedagogical tool in the teaching-learning methodology in higher education. In this same order of ideas, the performing arts have great value to enter into a holistic learning; what is sought is the generation of learning that crosses barriers, that is, that reflects reality and affects new proposals in the environment.

This type of learning connects emotion and reason in a masterful way since through the performing arts, students are able to seek solutions to real problems (problem-based learning), create projects that motivate them (project-based learning), have healthy interactions between peers (cooperative learning), treating at all times the active learning characteristic of these methodologies and providing individual and group meaning to their formative period (Pérez-Aldeguer, 2017).

2.5 Description of the PMDPM

Based on the theoretical review carried out by the PMDPM, it creates an academic space for scientific dissemination in which young university students express in a practical way the knowledge acquired in their academic training, through prototypes, research models and / or business incubation; embodied in modular projects that contribute to the solution of any problem identified in their immediate environment and that favor the well-being of society.

Another purpose of the PMDPM, is to promote among the university community, the development of skills of expression, communication and writing, through the presentation of scientific posters, ecological projects and unpublished plays, in order to spread chemical, ecological knowledge, pharmacological, as well as promoting ethics and morals in the student community and in society in general.

Finally, the PMDPM is described as a trigger in the training of young university talents by contributing to the scientific and technological development of the entity, through the application and experience of specific techniques focused on the development of their skills, in addition to promoting participation Early life of college students in scientific research and technological development.

2.6 Implementation of the PMDPM

2.6.1 Preparatory phase: Call and development of theoretical-experimental projects

At the beginning of each school year, teachers and researchers who are members of the technical support group of the Multidisciplinary Program for the Development of Modular Projects (PMDPM), invite young university students to participate with project proposals; The guidelines are delivered in writing and it is explained that it must start from the identification of any problem in its immediate environment, continuing with the realization of an alternative solution, focusing it on various areas of knowledge such as analytical chemistry, biology, pharmacy, ecology and the performing arts.

Each participating team presents its proposal in writing to the technical committee of the program, who performs a prior evaluation based on bibliographic resources and scientific papers, verifying the viability of the project, in addition to the availability of materials, equipment, laboratories, academic and research staff, finally generates a verdict of the proposal. The proposal being accepted, the students proceed to carry out the corresponding experimentation to present their progress reports to the teacher or researcher assigned as the person in charge of the project.

During these stages, young university students have continuous face-to-face, virtual or electronic counseling to facilitate the process. Finally, the young university students, in collaboration with the project advisor, carry out the analysis of experimental data and present it in poster format in the academic space for scientific dissemination, attaching the full document of the project.

2.6.2 Presentation phase: Project evaluation

In this phase, the logistics of the academic space for scientific dissemination are carried out, the program coordinators ensure that they have the necessary material such as screens, tables, chairs, screens, computer equipment, projectors, posters, stationery, etc. Meanwhile, the teams participating in the program present their prototypes or research models to the technical committee, made up of professors and researchers from the public university. At the end of the presentations, the technical committee evaluates and gives feedback to the university students to optimize their projects or research models.

Weighted proposals with a score higher than 80 points, with a maximum of 100 points, are considered as a modular project of the selected area of knowledge. The best projects of each edition of the program are advised with greater impetus for their participation in national and international congresses. Finally, the acknowledgments of participation in the program are delivered.

The main current advantages of the evaluation of projects in international dissemination focus on the fact that students have feedback from research experts that allows the improvement of the projects presented to increase their quality; in addition, the development of projects with scientific and methodological rigor is generated, allowing their approval to be published at an international level; as well as the increase in the explanation of various problems with a direct contribution to the generation of knowledge.

2.6.3 Follow-up phase: Diffusion and implementation of innovations

The coordinators of this academic space for scientific dissemination, monitor the best weighted projects in each edition, integrating them into the scientific research work team, through which modular projects are complemented until they have the profile and comply with the necessary guidelines to be presented in a congress of scientific dissemination at the national and / or international level. Also, university students are linked in scientific research stays, where they will continue to enrich their knowledge in the area of scientific research.

Another modality considered as a modular project in the public university, is the realization of diffusion campaigns and ecological campaigns, which benefit the social development and the sustainability of our entity. University students who so wish, develop projects related to the performing arts, aimed at dissemination campaigns. They join the theater group "Spontaneous Reaction" where they participate in the realization of original scripts (unpublished works) that are later staged in a cultural or social event. At the end of the play, evaluation activities, discussion forums, interviews, etc. continue. The theme to be developed in each work has the purpose of raising awareness and disseminating scientific knowledge, referring to chemical, biological, pharmacological, ecological, ethical or social issues.

On the other hand, university students who wish to participate in ecological campaigns, work according to the guidelines of the Eco-sustainable Program for Institutional Management of Solid Urban Waste (PREMI), focusing on sustainability activities such as the rehabilitation of green spaces, campaigns for the collection of paper, plastics and electronic waste, the giving of workshops on paper making and reuse of available resources and collaborating in the Conference With Environment Science.

3. Method

3.1 Research type and design

This research presents a quantitative approach, of a non-experimental type with a cross-sectional section (Hernández, Fernández & Baptista, 2014; Bernal, 2016). The technique used was the documentary review of a historical printed report of student participation in the PMDPM for the period 2014-2020 developed by those responsible for it, in order to quantify the data and identify the impact.

3.2 Variables

3.2.1 Research project variable

It corresponds to the number of scientific research projects focused on various areas of knowledge such as analytical chemistry, biology, pharmacy, ecology and the performing arts, which start from a problem detected as a research idea and a solution proposal by undergraduate students.

3.2.2 Modular projects variable

It is identified as the number of scientific research projects that become modular projects, which were evaluated by means of a rubric by the technical committee, being capable of being published with scientific and technological input.

3.2.3 Participation in congresses variable

Corresponds to the number of scientific research projects, accepted as modular projects that participate in science congresses at national and international level, in poster or presentation mode.

3.2.4 Electronic book variable

It is the number of scientific research projects that after participating in national and international science congresses, in poster or presentation mode, are published in an electronic book.

3.2.5 Published papers variable

Corresponds to the number of research projects in article mode, published in national and international peer-reviewed journals.

3.3 Measuring instrument

The instrument used to collect information was a matrix for the collection of quantitative information, which covers the period from 2014 to 2020, of its own construction, where the variables under study are indicated and the record of the number of products obtained from participation in the PMDPM.

3.4 Participants

809 undergraduate students from the third to the sixth semester of the degrees in Chemistry, Chemical Engineering and Chemical Pharmacology were considered.

3.5 Procedure

The information collection was carried out through a matrix that integrates the variables under study, for this, the historical report of student participation in the PMDPM for the period 2014 - 2020 was used, to obtain the necessary data and meet the objective of the present investigation.

3.6 Data analysis

Descriptive statistics were used for data analysis, counting, tables and graphs, comparing the findings by year.

4. Results and discussion

After the documentary review with a quantitative approach of the historical report of student participation in the PMDPM, it was found that, as of June 2014, the first exhibition of scientific research projects with physicochemical applications for the study of biological systems was inaugurated. in the facilities of the university center of the public university under study, with the participation of students from the third and fourth semester of the Bachelor's Degree in Pharmaceutical Chemistry Biologist (LQFB) (Expo, 2014).

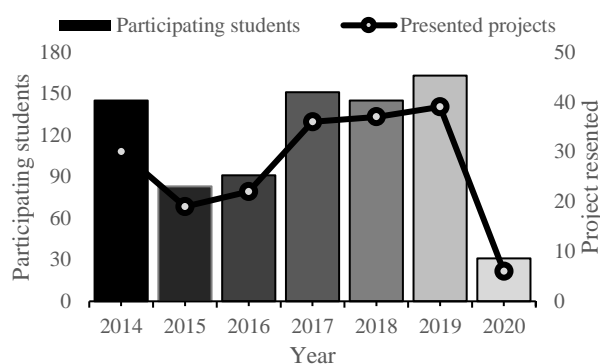
The initial conditions to generate this PMDPM model contemplated modular projects that brought together both formal and content aspects, developed by third and fourth semester LQFB undergraduate students, who were subjected to compliance with various indicators such as: originality consistent in the design, distribution of the elements in the space and visual route; use of the color factor and visual impact (attractiveness of the project); clarity in the presentation of information and proper use of language and spelling; quality and logical sequence of the presentation; inclusion of the institution of origin; elaboration according to the subject of the title; addressed to the agreed recipients; offering relevant information to the agreed recipients; content of the students' points of view, in addition to the information collected; presentation of updated and innovative information; facilitating recipients to have useful support tools in their professional work; evidence of acquisition of knowledge of different subjects by students; incorporation of the bibliography used; and defense of the authors on the theme of the project.

The first edition had the participation of 145 students of the LQFB career, which is equivalent to a representative sample with a 95% confidence level and a margin of error of $\pm 5\%$, of 232 possible participants, allowing the validity of the model proposed in this research, which presented 30 projects with physicochemical approaches in the modalities of oral presentation, poster presentation and prototype presentation.

A significant finding was that, over time, the PMDPM has been carried out uninterruptedly, two editions per year starting in 2015, in addition to expanding the areas of knowledge and incorporating projects carried out by students of the Degree in Chemistry (LQUI) and the Bachelor's Degree in Chemical Engineering (LIQU) from this public university in Jalisco.

In graphic 1, the evolutionary behavior of the PMDPM is shown during the period between June 2014 and August 2020, it is possible to appreciate three critical stages that describe the participation of students through projects presented in the program. In the first stage (2014), there is a participation of 145 students who presented 30 projects, this great result was due to the work carried out in the promotion and dissemination of the program; However, in 2015 and 2016, the second stage arises, in which a significant decrease can be seen with the participation of 174 students and 41 projects presented in this period, this effect was caused by the limitation of educational programs incorporated into the program (LQFB only).

As of 2017 and until 2019, the PMDPM is consolidated, appearing the third stage, in which there is the maximum participation in the triennium of 163 students and 38 projects, this result was obtained by the strategy of incorporation of the careers of LQUI and LIQU as fundamental knowledge areas of the program, managing to integrate modular projects carried out by students of these careers.



Graphic 1 Participation of undergraduate students in the PMDPM

Source: Own elaboration from data obtained from PMDPM 2014-2020, of the documentary review carried out on the institutional records held by those in charge of its implementation

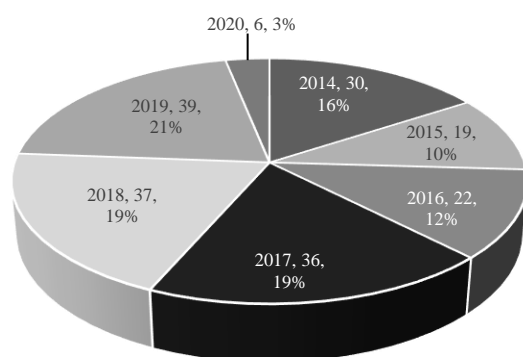
Table 1 shows the relationship of the results obtained in the program during the period between 2014 and 2020.

Year	Projects presented	Participating students	Modular projects	Participation in congresses	E-books	Published papers
2014	30	145	5			0
2015	19	83	8			0
2016	22	91	14			1
2017	36	151	32			0
2018	37	145	35			1
2019	39	165	38			2
2020	6	31	6			1
Total	189	809	138			5

Table 1 Results of the PMDPM in the period between 2014 and 2020

Source: Own elaboration based on the data obtained from the PMDPM 2014-2020, of the documentary review carried out on the institutional records held by those in charge of its implementation

During the analyzed period, 12 editions of the PMDPM were carried out, with the participation of 809 students from the LQFB, LQUI and LIQU careers, who developed 189 projects that have been presented in the program; 2019 being the most productive year with 21% of the total projects presented in the PMDPM (see graph 2). The pie chart shows the year of publication, followed by the number of projects presented and concludes with the representative percentage of the total number of projects.



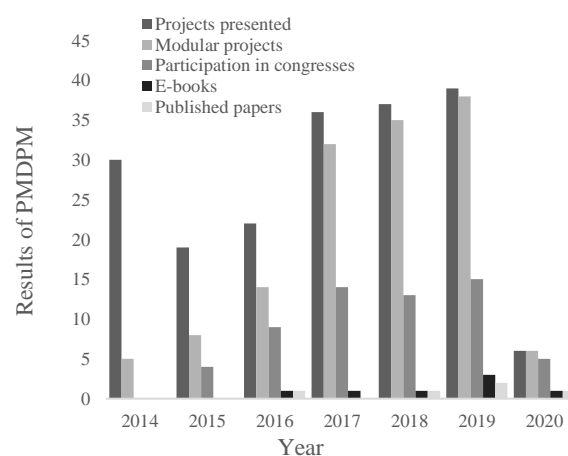
Graphic 2 Relationship of the participation of projects in the PMDPM

Source: Own elaboration from data obtained from PMDPM 2014-2020, of the documentary review carried out on the institutional records held by those in charge of its implementation

It is important to mention that the decrease in participating projects in the 2020 PMDPM corresponds to the effect caused by the global health emergency regarding COVID-19, a circumstance that has so far prevented experimental work in laboratories and face-to-face activities at the university center of the public university participating in this research.

On the other hand, of all the projects presented in the PMDPM, 138 have been approved by the technical committee as "Modular Projects" applied to the different areas of knowledge of the participating degrees, in relation to the 189 projects presented (consult Table 1), corresponding to 73% effectiveness of the program.

In graphic 3, the production obtained through the implementation of the PMDPM is shown, which has influenced young university students to participate with 60 modular projects (43.47% of the modular projects accepted) in different congresses of scientific dissemination at national and international level, among which those carried out by the Mexican Chemical Society (SQM), the Mexican Academy for Research and Teaching in Chemical Engineering (AMIDIQ), and the Academia Journals (AJ) stand out. Furthermore, it has collaborated with the participation of modular projects in 7 chapters of digital books and in the publication of 5 papers in journals with rigorous arbitration and indexed in EBSCO.



Graphic 3 Results obtained from the PMDPM in relation to modular projects, participation in congress, e-book chapters and published papers

Source: Own elaboration from data obtained from PMDPM 2014-2020, of the documentary review carried out on the institutional records held by those in charge of its implementation

As for the dissemination of the exact sciences and engineering through the performing arts, the theater group "Spontaneous Reaction" was created, made up of undergraduate students with creative vision and artistic abilities. The main function of the theater group was to create unpublished works with themes of environmental awareness and dissemination of scientific and cultural knowledge.

To date, 30 original scripts have been designed and staged in different cultural events, university forums, national congresses and in civil associations such as Narices Rojas A.C. The information regarding these scripts can be seen in table 2.

In addition to this, in 2016 the theater group was consolidated as part of the Social Service Program in the university center of the public university participating in this research, which was oriented to support the cultural activities of undergraduate students; without a doubt, a very significant achievement for the Multidisciplinary Program for the Development of Modular Projects (PMDPM).

No.	Name of the work	Subject	Presented in:
1	Philosophical water	Alchemy	Cultural Scientific Event of the Pharmaceutical Chemist Biologist
2	My sweet human sacrifice	Alchemy	Cultural Scientific Event of the Bachelor of Chemistry
3	From elements to compounds	Chemical	National Congress of Pharmacy
4	Glucose in the country of enzymes (krebs cycle)	Biochemical	Cultural Scientific Event of the Bachelor of Chemistry
5	Hormone initiative	Biochemical	Cultural Scientific Event of the Bachelor of Chemistry
6	Metabolized in life	Biochemical	Civil Association for Children with Cancer Narices Rojas
7	Cells war	Biochemical	National Congress of Chemistry
8	The ghost of expired drugs	Pharmacist	Cultural Scientific Event of the Pharmaceutical Chemist Biologist
9	Errors of medication	Pharmacist	Civil Association for Children with Cancer Narices Rojas
10	SAEP- Serotonergic combat	Pharmacist	National Congress of Pharmacy
11	The magic formula to heal	Pharmacist	Cultural Scientific Event of the Pharmaceutical Chemist Biologist
12	My pneumonia fever	Medicine	Old Civil Hospital, Social Security Pediatric Specialties Tower
13	My abnormal normality	Psychiatric Medicine	CUCS Psychiatry Conference
14	Metro fail	Cancer	Civil Association for Children with Cancer Narices Rojas
15	Immunological detectives	Immunology	Western Intellectual Property Congress CUCS
16	Mental resonance	Criminalistics	Cultural Scientific Event of the Pharmaceutical Chemist Biologist
17	Head shot	Criminalistics	National Congress of Pharmacy
18	The three feet to the cat	Social Service	X Academic Meeting of Social Work
19	Heroes never die	Ecological	House Home of Guadalajara
20	Plasticize my life	Ecological	Rambla Cataluña of the University of Guadalajara
21	Six reasons not to Live on earth	Ecological	Rambla Cataluña of the University of Guadalajara
22	Recycle my life	Ecological	Conference of With Science Environmental (JACC)
23	Five minutes more	Ecological	Mixed Secondary 71 "Idolina De Cosío Vidaurri"
24	Chemical friendships	Infant	Primary Urbana 124 "Margarita Maza de Juárez"
25	The children's crab bucket	Infant	"Salvation Army" Children's Home
26	Fluoride and the thieves of children's day	Infant	"La Luz" Children's Home
27	Looking for the perfect alchemist	Pastorela	"Salvation Army" Children's Home
28	Chemical pastorela	Pastorela	Old Civil Hospital, Social Security Pediatric Specialties Tower
29	Deadly sins	Pastorela	Civil Association for Children with Cancer Narices Rojas
30	Pastorela according to Satan	Pastorela	Mixed Secondary 35 "Ricardo Flores Magón"

Table 2 List of original scripts created and staged by the theater group Spontaneous Reaction

Source: Own elaboration from data obtained from PMDPM 2014-2020, of the documentary review carried out on the institutional records held by those in charge of its implementation

Finally, in the field of environment, the guidelines of the Institutional Environmental Sustainability Plan of the university center belonging to the public university participating in this research and the Eco-sustainable Program for the Institutional Management of Urban Solid Waste were designed.

Through these environmental sustainability programs, undergraduate students have participated in 4 campaigns to collect paper and plastic, an edition of the Conference With Environmental Science 2019 and 3 workshops for the reuse of available resources such as paper, plastic and metals. Additionally, they have rehabilitated green spaces at this university and collaborated in the Eco Olympiad for high school students. Now, as part of the discussion, it is possible to go back to the postulate of the World Declaration on Higher Education in the XXI Century, which establishes that, in the new teaching model, the student becomes the protagonist of the educational system, therefore, higher education has to adapt its teaching methods. In this sense, authors such as Maldonado (2008) and Murrieta (2013) establish that, in the model focused on learning, the teacher must be a facilitator of knowledge and implement methodologies so that the student appropriates knowledge autonomously, multidisciplinary and practice.

While Roldan (2000), affirms that students must develop specific skills and abilities that allow them better access to the labor market and to this is added the incorporation into the development of scientific research projects. In this sense, the implementation of the PMDPM and the results obtained during the analyzed period have undoubtedly contributed to the new university teaching model, generating an academic space for scientific dissemination in which students develop skills and capacities that help to achieve competencias established in the graduation profile of the careers involved in the program. On the other hand, authors such as Blank & Harweel (1997) as well as Bell (2010) and Martí, et al., (2010), affirm in their independent studies that Project-Based Learning (PBL) is a learning model that enables students to acquire skills and abilities with real-world application beyond the classroom. In this way and in coherence with said research, the quantitative analysis of the incorporation of undergraduate students to scientific work through the implementation of this program shows that it has been possible to influence the training of young university talents in terms of innovation, science, technology, performing arts and the environment, which results in the creation of prototypes or unpublished research models, according to the reality of their immediate surroundings.

The results obtained from this research identify, among others, the development of projects such as early initiation to scientific research, the approval of modular projects, participation in scientific dissemination congresses, the publication of papers in research journals, the design of scripts theater and participation in environmental awareness campaigns. In this way, the PMDPM has effectively contributed to the modular study plan coined by the university center of the public university in Jalisco, in which it was sought to favor the pedagogy of projects in order to develop specific skills and abilities in students undergraduate.

It is also possible to highlight that the PMDPM, in the process of evaluating the projects presented by undergraduate students, considered both academic and scientific endorsement, support granted by professors and researchers from the public university and that later in the scientific dissemination, it was ratified by institutions recognized nationally and internationally. Such is the case, with the projects "Determination of hexavalent chromium in the soil near the tanning factory in Guadalajara, Jalisco" and "Determination of lead, cadmium and zinc present in enamelled and non-enamelled clay jars of the municipality of Tonalá, Jalisco", which were accepted to participate in the 53rd Mexican Congress of Chemistry, held by the Chemical Society of Mexico A.C., and obtained favorable criticism at the congress, arousing great interest from specialist researchers in the environmental area.

Another similar case is the one presented at the XXXIX National Meeting of AMIDIQ, 2018. In which the modular projects "Synthesis and characterization of hollow gold nano-coats loaded with doxorubicin for the treatment of ovarian cancer" and "Study of the capacity of solubilization of doxorubicin in nanostructures formed by the F127 / Water system", both projects contributing to the fight against cancer through the use of nanotechnology as a viable alternative against the fight against this disease.

Now, in the field of the environment, with the design of the Institutional Environmental Sustainability Plan of the university center of the university under study, the awareness of the university community was achieved, regarding the reuse of available resources such as paper, plastic and metal, carrying out ecological activities such as rehabilitation campaigns in green spaces, collecting paper, plastics and electronic waste, and participating in the Conference With Environmental Science (JACC).

On the other hand, regarding the performing arts, Perez-Aldeguer (2017), points out that, through music, dance and theater, students are able to seek solutions to real problems. In this same sense, Núñez & Navarro (2017) affirm that dramatization is an integrating instrument that favors expression and communication in all fields of teaching. It is worth mentioning that in the PMDPM a specific area was integrated to the expression of the performing arts, where undergraduate students organized food collection campaigns (non-perishable food and personal cleaning items), non-warlike toys, clothing and blankets in good condition within the university facilities, as part of a social and community service, in order to donate the proceeds to the civil association of children with cancer Narices Rojas A.C., and to the "Salvation Army A.C." children's homes and "La Luz A.C." These campaigns culminated in the staging of a play by the theater group "Spontaneous Reaction", with themes that involved messages oriented to science, ethical behavior and personal improvement.

Thus, through the achievements identified in this research, the central hypothesis is confirmed, since, of the 1,440 undergraduate students as a universe of work, that is, as a potential population, it was found that only 56%, equivalent to 809 students (see table 1), participated in research, scientific dissemination and performing arts projects.

Additionally, it was corroborated, as indicated by the theoretical review supporting this article, that young university students develop certain specific abilities and skills in scientific, cultural and environmental areas, during and after their participation in various activities, such as their incorporation into the PMDPM.

5. Annexes

The format of the quantitative information collection matrix from 2014 to 2020 is shown (see table 3).

Year	Projects presented	Participating students	Modular projects	Participation in congresses	E-books	Published papers
2014						
2015						
2016						
2017						
2018						
2019						
2020						
Total						

Table 3 Information collection matrix

Source: Own elaboration (2020)

Moreover, the evaluation format of the PMDPM research projects is integrated, where the formal aspects of the project and the content aspects are considered (see table 4).

No.	Characteristics to be evaluated	Maximum score
Formal aspects of the project		
1	Originality: design, distribution of elements in space and visual tour.	2
2	Use of the color factor and visual impact (attractiveness of the project).	2
3	Clarity in the presentation of information and proper use of language and spelling.	2
4	Quality and logical sequence of the presentation.	2
5	Includes the institution of origin.	2
TOTAL		10
Project content aspects		
6	Prepared according to the subject of the title.	10
7	Aimed at the intended recipients.	5
8	Provides relevant information for the intended recipients.	10
9	Contains the points of view of the students, in addition to the information collected.	5
10	Provides up-to-date and innovative information.	15
11	Allows recipients to have useful support tools in their professional work.	15
12	Evidence of acquisition of knowledge of different subjects by students.	10
13	Includes bibliography used.	10
14	Defense of the authors on the theme of the project.	10
TOTAL		90

Table 4 Project evaluation format

Source: Own elaboration, based on the document review of the PMDPM (2020)

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7. Conclusions and recommendations

Through the quantitative analysis carried out in this research, the main finding shows that the number of undergraduate students incorporated into programs for the development of projects, such as the PMDPM of the public university participating in this research, is able to foster interest in science with the use of the scientific method and awareness of the various problems that afflict society. Therefore, entering undergraduate students in scientific work is more than the generation of innovative ideas; given that it becomes a way of life committed to society and the environment, through innovative actions under a scientific and technological approach, with applicability in the daily actions of undergraduate students, as an invaluable and highly necessary human talent today.

Further to this, the teaching-learning process achieves its mission at this educational level, where the student is the center of this process and their involvement is essential so that learning effectively generates knowledge and it is applied, through various innovation projects, science and technology, with an approach that results in the creation of prototypes or unpublished research models, according to the social reality of the state of Jalisco.

The main limitations of the research focus on the scope of the documentary review carried out, since only three careers of exact sciences and engineering were contemplated from a university center of the public university analyzed, in the period from 2014 to 2020, where implemented the PMDPM.

However, future research will have to study how other careers in different university centers, both public and private universities, are incorporating undergraduate students in scientific work; in addition to making comparisons to generalize the behavior of this research topic with a greater scope.

Regarding the quantitative analysis carried out, it was limited to descriptive statistics, therefore, in future work, new statistical techniques will have to be incorporated, such as Exploratory Factor Analysis (EFA), which determines the factors that explain the problem studied, with the incorporation of new variables, given the complexity of the present investigation.

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