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Project Development and Participation in Competitions as Strategies for the Development of Employability Competences Required by Knowledge-Oriented Sectors

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Abstract

This paper presents the results obtained by applying Methodology for the Development of Potentially Innovative Technological Projects, with a focus on employability based on the skills and competencies developed. Among these are communication, project management, technical knowledge, critical thinking, entrepreneurship, innovation, and leadership. One of the first stages of the methodology involves motivating and committing the students to the projects they will develop. In contrast, in the last stages there is participation in competitions, which are a way of making the projects carried out visible, as well as the potential and rigorous training of the participants, which is not limited to techno-scientific skills and knowledge, but also involves complementary skills and competencies valued by employers in companies corresponding to the knowledge-oriented sectors. The dissemination stage is another of the final stages of the methodology, which has contributed to the visibility of results at regional, national, and international levels, demonstrating that the globalized scope is a valuable tool for integrating graduates into the productive sector.

Keywords: Innovative Projects, Competences, Dissemination, Networking, Expert Panel.

1 Introduction

In the Global Innovation Index 2023, "Innovation in the Face of Uncertainty," Mexico, ranked 58th, is positioned third among Latin American countries, following Brazil (49th) and Chile (52nd). Mexico is the country of interest in this work. Table 1 presents some of the parameters related to this work, as obtained from [1]. In Table 1, it can be observed that, in Human Capital and Research, the number of graduates in science and engineering ranges from 41, which needs to be increased, as it is not specified as a strength. Fortunately, it has a very high rank in High-tech manufacturing, at 16, which is considered a strength and an indicator of a substantial income group. It should be noted that Mexico tops in Creative outputs (45th). Engineering education is considered strategic in this index, due to its impact on the competitiveness of companies, among other factors. Currently, given the nearshoring environment, the challenge is that education should respond to the needs of human resource training by redefining its priorities. Among these, in addition to knowledge in technology and engineering, the improvement of communication skills and training in topics related to business and innovation are highlighted [2]. Scientific and mathematical thinking, as well as socioemotional skills such as active listening and flexibility, are also identified as indispensable skills [3].

Table 1. Mexico: Economy Profile, with a focus on specific pillars and sub-pillars. Source [1]

		Score/Value	Rank
	Human capital and research		
2.2.2	Graduates in science and engineering, %	25.8	41
	Knowledge and technology outputs		
6.2.4	High-tech manufacturing, %	46.3	16●◆
	Creative outputs		
7.3.4	Mobile app creation/bn PPP$ GDP	64.1	69

NOTES: ● indicates a strength; ◆ an income group strength.

In the context of the Fourth Industrial Revolution (I4.0) and the transition towards knowledge-based economies, where intangibles hold high value, engineering education is paramount. It requires transformation to address current challenges, with a focus on the social and environmental impact of the solutions developed. In [4], the direct connection between the industrial revolutions and the resulting transformations in modern engineering education is analyzed. It is also noted that the technologies used in Industry 4.0 have already been investigated and applied in technical universities for at least two decades. Among the teaching-learning experiences analyzed in that work, international creativity and design competitions, summer schools, hackathons, as well as their progressive contribution to the valorization of student-centered activities and the dissemination of CDIO (Conceive-Design-Implement-Operate) methods in all engineering disciplines stand out.

The content of this article is as follows: In Section 1, information about the challenge that initiated this research, some fundamentals, and the methodology developed for innovative projects is briefly described. In section 2, the theoretical framework is described. Some of the projects carried out are presented in Section 3, along with their impact on student hiring. In Section 4, the importance of disseminating results and networking in enhancing employability is analyzed. Section 5 summarizes the findings and provides concluding remarks, as well as suggestions for future work.

2 Theoretical Framework

Currently, several competitions are included throughout the development of Congresses or Conferences on Science, Technology, or Innovation, where, in some cases, investors or company members participate among the evaluators, which in some cases allows for obtaining, in addition to the corresponding recognition, advice, mentoring, or investment interest. The importance of networking once again becomes relevant.

Education in Engineering is depicted in [4] as:

- Holistic, flexible, and Dynamic approach.
- Student-centered and sustainability focused.
- PBL (Project-Based Learning) hybridized with service-learning.
- Focus on personal and professional development.
- Research-oriented and technology-aided.
- Collaborative, enjoyable, humanistic, international.
- Ethical compromise of students and institutions.
- Engineers as solvers of global challenges.

On the other hand, a gap has been identified between the needs of industry and the competencies of engineering graduates, a situation in which courses dedicated to project development are crucial for developing the required skills. In [5] it is shown how such courses are designed is determinant, showing that under the traditional way of developing projects, there are better results in planning and managing Project, but if one opts for projects where the challenge-based approach combined with Design Thinking is used, skills on creativity, leadership, and entrepreneurship are developed. It was identified that engineering students´ projects tend to be more inventions than innovations, since they are generally not developed to create and capture value. As a result, the industry's perceived skills gap remains unaddressed.

In [6], the creativity and innovative capacity of engineers are recognized as essential for the functioning and advancement of our societies, as engineers contribute decisively to the innovation process, which has a significant impact on national economies. Engineers need to develop competencies in various transferable skills and must be exceptionally proficient in working across borders, including those with different cultural backgrounds [7].

In the state of Morelos, Mexico, several Institutions of higher education (IHEs) coexist, with engineering being a primary area of focus that covers diverse disciplines. At the Universidad Tecnológica del Estado de Morelos, UTEZ, part of the Tecnológico de México, for several years, with the collaboration of professors and researchers from other universities, the structuring and application of a new methodology has been applied in the development of projects that correspond to the four-month courses called Integrating learning units. The knowledge and experience of experts in electronics, robotics, computing, and other technological disciplines have been complemented by areas such as project management, entrepreneurship, and innovation, generating highly relevant projects that have served as the basis for participation in regional, national, and international competitions, gradually earning recognition and leadership.

The comprehensive methodology shown in Fig. 1 considers several well-known strategies, whose functionality has been widely demonstrated. This methodology is called Methodology for Development of Potentially Innovative Technological Projects, which seeks to support the training of students, as well as to increase the innovation potential of the projects carried out in the Internet of Things Laboratory of Universidad Tecnológica Emiliano Zapata del Estado de Morelos, with the support and evaluation of experts in engineering, technology, entrepreneurship and innovation from other institutions, as part of the activities carried out in the Integrating learning units, developed in the third, fifth and tenth semesters of the Mechatronics career. This methodology was reported in [8]. It should be noted that, in cases where opportunities for improvement are identified, these projects are revisited to implement improvements and enhance the competitiveness of the student teams. The technical skills of the experts are also utilized through short-term projects and dissertations required to obtain a degree in higher technology or engineering. This mobility favors the collaboration of various experts.

This methodology aims to support the training of students as part of the activities conducted in the integrative learning units of the Mechatronics program. These learning units are four-monthly, so the methodology must be agile, according to the time available. The blue lines show the desirable successive sequence; however, in each of them it may be necessary to go back to previous stages, which is shown with the red lines (see Fig.1). That is, it is a process in which it is possible to move forward or backward to any stage, according to the needs that arise.

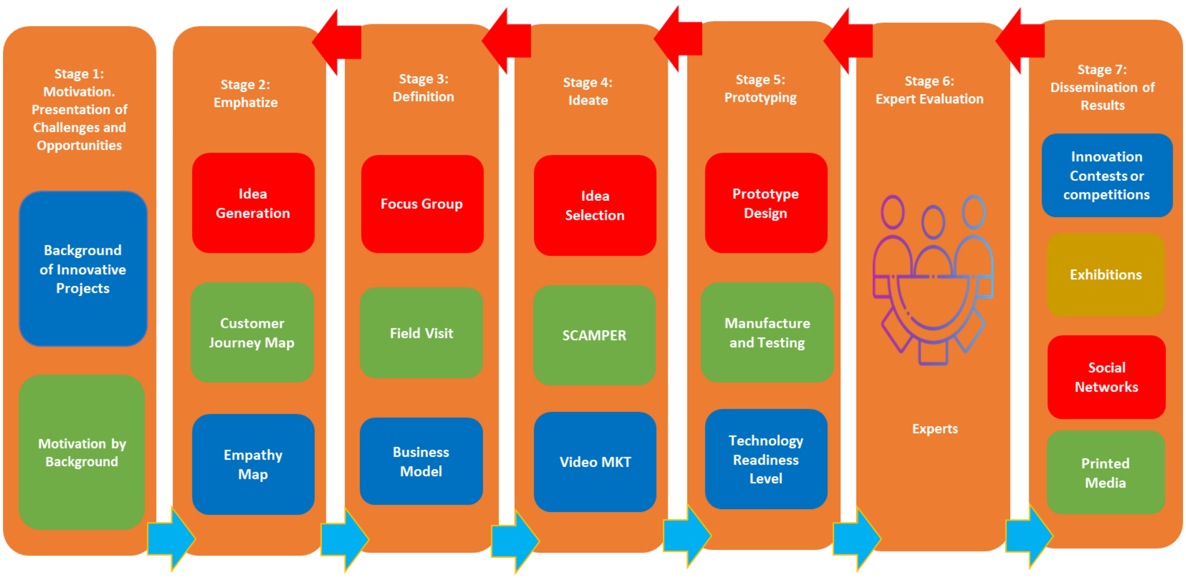

Figure 1: Methodology for Development of Potentially Innovative Technological Projects. Adapted from [8]

In summary, this comprehensive methodology consists of the following steps:

- *Stage 1. Motivation. Presentation of Challenges and Opportunities.*

  This stage aims to motivate the participating teams by providing specific external and internal examples, enabling participants to observe that it is possible to develop successful projects that address complex problems with social or environmental impact. Additionally, a series of videos showcasing innovation projects was presented during the James Dyson Award call.

  Knowledge of the Sustainable Development Goals (SDGs) is considered substantial in raising awareness and commitment, both socially and environmentally. Strategic lines of the Singularity University Entrepreneurship Program also contribute to achieving this goal.

  At this stage, previously developed projects are shown, along with information about the awards they have received.

- *Stage 2. Empathize.*

  Through Idea Generation, Customer Journey Mapping, and Empathy Mapping, the problem is analyzed and empathized through knowledge and interaction with the sector that has the problem to be solved.

  The use of these tools allows students to develop skills that they can apply in future projects, being that in all of them to establish empathy towards people who have a need or aspiration, allows us to propose a solution that is appropriate more efficiently, increasing in due course, the possibility of purchase of the product or service developed.

- *Stage 3. Definition.*

  Through focus groups, field visits, and Business Models, the proposal is defined, and the segments that make up the Business Map are identified.

  The realization of the business model enables the student to gain a global perspective on the project, as well as its commercial potential. It is also a valuable tool for visualizing the profitability of the business represented, as well as its potential scalability, making it an attractive investment opportunity. It also favors the identification of its novelty and potential impact.

- *Stage 4. Ideate.*

  From the Idea Selection, Scamper, and Video Marketing, the shape, design, or sketch that will give rise to the prototype, serving as the basis for the materialization of the proposed technical solution, is established.

  With tools such as SCAMPER, students develop the ability to employ a wide variety of strategies, enabling them to solve problems in a structured manner and enhance their creative thinking. In this way, the acquired experience facilitates the use of similar tools to support the ideation process, as summarized, for example, in TRIZ.

  In the ideation process, the teacher's guidance is fundamental in developing this skill in students.

  The selection of the idea to be implemented is based on the teacher's vision and experience, who serves as the primary support for carrying out this activity.

  On the other hand, creating videos or other visual aids to deliver presentations and disseminate their projects, which is also sometimes one of the elements required to participate in competitions, develops the creativity of students, who can learn to utilize other digital tools.

- *Stage 5. Prototyping.*

  From Prototype design, Manufacture, and Testing, as well as Technology Readiness Level (TRL), it is possible to obtain a preliminary prototype and conduct the first tests.

  In the prototype design process, a sketch, a 3D print, or a design made in a CAD program is provided to visualize the product in a physical form and perform the following activity. Remember that we already have an initial business model, which provides us with background information on materials and costs, enabling us to make a more concrete proposal for the prototype to be developed on a realistic basis.

  Prototype manufacturing presents a valuable learning opportunity, as it often involves integrating various technologies, including 3D printing, programming, automation, and control, utilizing sensors and actuators as supporting elements. This results in the application of previously acquired knowledge, as well as the acquisition of new knowledge and the learning of new hardware or software tools.

The TRL analysis provides a comprehensive view of the level of progress and the expectations for improvement and development. It should be noted that, in traditional education, this was not an indicator; therefore, either the prototypes made were tested in uncontrolled environments, or they had to be improved or matured in such a way that they could be mass-produced and commercialized.

- *Stage 6. Experts´ Evaluation.*

  The projects are presented to a panel of experts, and feedback is obtained, which allows us to make the necessary adjustments, both from a technical perspective and in their presentation, to participate in technological innovation competitions. The profiles of these experts are complementary, so that their contribution and guidance strengthen both the development of the projects and the presentation skills of the student teams. Professors and researchers from other higher education institutions, as well as entrepreneurs, have been considered (Fig. 2).

  The opinions and recommendations are taken into consideration when making improvements to the presented projects, thereby increasing their level of competitiveness.

- *Stage 7. Dissemination of Results.*

  Participation in innovative contests or competitions is encouraged, as well as Exhibitions, where teams can submit and show their projects. Dissemination of the results after competitions and exhibitions is essential to make them visible (Fig. 3).

  At the end of the integrative learning units, exhibitions are held, during which some members of the expert panel follow up on the improvements implemented in the projects. At this level, awards are also given to the best projects in different areas.

  Throughout the application of this methodology, lines of knowledge application have been identified, which have allowed the continuity of some projects presented in competitions that focus on these lines. Among the lines being developed are solutions for beach cleaning, the use of drones for various applications, prototypes for agriculture and healthcare, security devices, and more. In some cases, the developed prototypes are accompanied by the required mobile applications to complement and facilitate their use. It is worth noting that, fortunately, we have had institutional support, which has enabled us to participate in regional, national, and international competitions.

In [9], it is recognized that engineering competitions can also create an environment that promotes effective learning. They can help students learn how to integrate technical and professional skills and knowledge into their engineering development. Due to the benefits, they offer in enhancing students' profiles by developing various skills, these types of activities should be implemented [10].

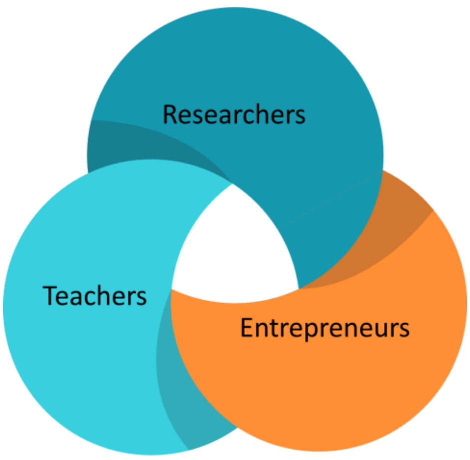

Figure 2: Panel of experts

In principle, this methodology was designed to enable graduates to become entrepreneurs through their projects, generating new sources of employment and addressing the employability needs they face. However, the current economic and social environment, as well as existing limitations in technology transfer, pose barriers that recent graduates from public universities often face. Alternatively, other graduates were expected to enter the productive sector or pursue further graduate studies. In this paper, we focus on the insertion of graduates participating in competitions and other technological competitions.

At each stage of this methodology, we aim to develop various skills, as outlined in Table 2, some of which have been identified based on [11].

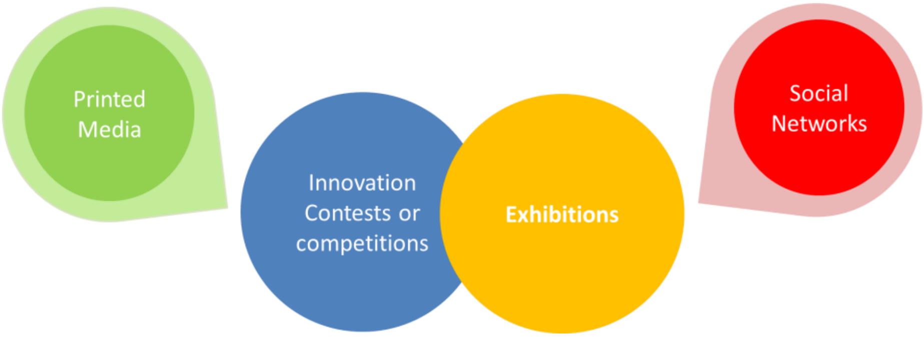

Figure 3: Stage 7. Dissemination of results

Table 2. Competences to be developed in each of the stages of the Methodology for the Development of Potentially Innovative Technological Projects

Stage	Sub-stage	Learning outcomes	Competences
1. Motivation. Presentation on Challenges and Opportunities	Background of Innovative Projects	Social and environmental context Knowledge of actual problems and solutions Motivation Commitment	Openness to experience, Critical thinking Solving problems
	Motivation by Background	Self-learning Self-determination Perceive challenge	Critical thinking Achievement orientation Emotional management Socioemotional for work
2. Empathize	Idea generation	Divergent thinking	Communication Critical thinking Collaborative work
	Customer Journey Mapping	Strategic Planning	Search, evaluation, and management of information
	Empathy Map	Empathy	Competences for transdisciplinary work
3. Definition	Focus Group	Social and environmental context	Competences for transdisciplinary work

	Field Visit	Strategic Planning	Competences for transdisciplinary work
	Business Model	Strategic Planning Innovation Organization	Entrepreneurship
4. Ideate	Idea Selection	Convergent thinking	Scientific reasoning Problem solving
	SCAMPER	Planning	Technical design Problem solving
	Video MKT	Innovation	Creativity Digital content creation
5. Prototyping	Prototype Design	Project management Technical skills	Disciplinary specifics Technical problem solving
	Manufacture and Testing	Implementing Time management Technical skills Documentation	Scientific reasoning Self-care
	Technology Readiness Level	Strategic planning	Critical thinking Competences for lifelong learning
6. Expert Evaluation	Presentation	Presentation Documentation	Critical thinking Oral and written communication Competences for lifelong learning
7. Dissemination of Results	Social Networks	Dissemination	Digital security
	Printed Media	Dissemination	Communication
	Innovation Contests or Competitions	Social and ethical responsibility	Leadership Oral and written communication Critical thinking Networking Interculturality

Exhibitions	Dissemination	Oral and written communication Critical thinking Networking

With the knowledge and skills acquired, companies in knowledge-oriented sectors seem to be the natural route to employability for graduates. These companies develop innovative products and new production processes. They have a significant impact on productivity, international competitiveness, job creation, and economic growth [12]. Its employees often work in Research and development (R&D), constantly updating and training, reinforcing their scientific and technological knowledge, and using it to create and develop new products and processes, as well as other activities required around them, from a technical or complementary point of view, including project management, or for commercial launch and follow-up. These activities are classified into high-tech manufacturing (HTM) and knowledge-intensive services (KIS) [12].

In [13] it is recognized the importance of developing innovation competences to reduce the gap between the needs of industry and the competences of engineering graduates. This study suggests developing these competences through project-based courses to address current societal challenges. They proposed that creativity, leadership and entrepreneurship are best developed through a challenge-based approach combined with Design Thinking. However, it is also recognized that training teachers in this creative methodology requires a high investment.

On the other hand, it is widely recognized that knowledge-intensive industries are those in which the generation and application of knowledge play a predominant role in driving economic activity. These industries can be a source of productivity growth in the future [14], making it essential that engineers interested in entering them have a strong background in both technology and engineering and soft skills.

In summary, the inclusion of skills related to employability in engineering education programs is necessary to prepare engineering graduates for professional engineering work better, as noted in [12]. In this paper, several projects developed are presented, through which skills have been developed or reinforced that are considered valuable by the business sector when hiring [15].

3 Projects carried out and their impact

In addition to the projects reported in [8], carried out using the methodology for the Development of Potentially Innovative Technological Projects shown in Fig. 1, in this section, four projects developed and defended in competitions are given:

- Smart dispenser
- Nounou
- Florence
- Ready order

All the projects, both those presented in [8] and the four presented here, followed each of the stages of the methodology developed. The projects presented here focus on SDG 3, Health and well-being. Additionally, all were developed up to Technology Readiness Level (TRL) 4.

3.1. Example of methodology application: Smart Dispenser

Objective: To design and implement a smart dispenser that allows company or organization personnel to receive controlled doses of sanitizer safely, allowing administrators to know who gets the service and manage the information received.

Results: This project also included a mobile application, designed to monitor who is receiving the service, whether they are wearing masks, the temperature of the users, and the available level of sanitizer. This project received an honorable mention in the Innovation Challenge Track Finals of IEEE Region 10. Preparing for Future Sustainable Transformational Technologies (2021).

Impact: Currently, two members of this team are working at Nissan, with one at Baxter and the other at Saint Go Bain, all of which are subsidiary companies based in Morelos, Mexico.

This Project was proposed during the COVID-19 pandemic in response to the need for automatic gel dispensers, as most of them in our country were mechanical at that time. For the development of the prototype, it was necessary:

- Develop an intelligent personnel recognition system.

- Implement infrared sensors for gel dispensing without the need to press.
- To issue messages to encourage hand washing, including voice commands.
- Develop an App for monitoring and information management.

In Stage 1, innovative projects developed in other instances were showcased, as well as those created by peers from previous generations. In 2021, the possibility of improving the Smart Dispenser, which was in a basic version, was identified.

In Stage 2, Empathize, the empathy map was created, focusing on the personnel in charge of the dispensers (Figure 4), in conjunction with the Customer Journey Mapping (Figure 5), which highlighted the need to incorporate functionalities such as integrating a time clock and leveraging face identification. In Figure 6, the CANVAS business model is provided. Figure 7 illustrates the implemented prototype, along with the development team.

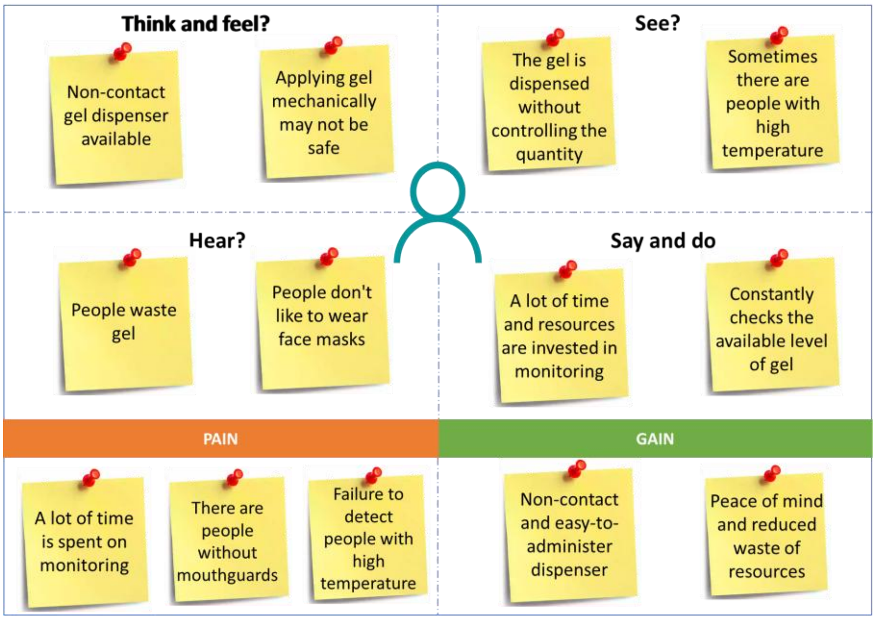

Figure 4: Empathy mapping

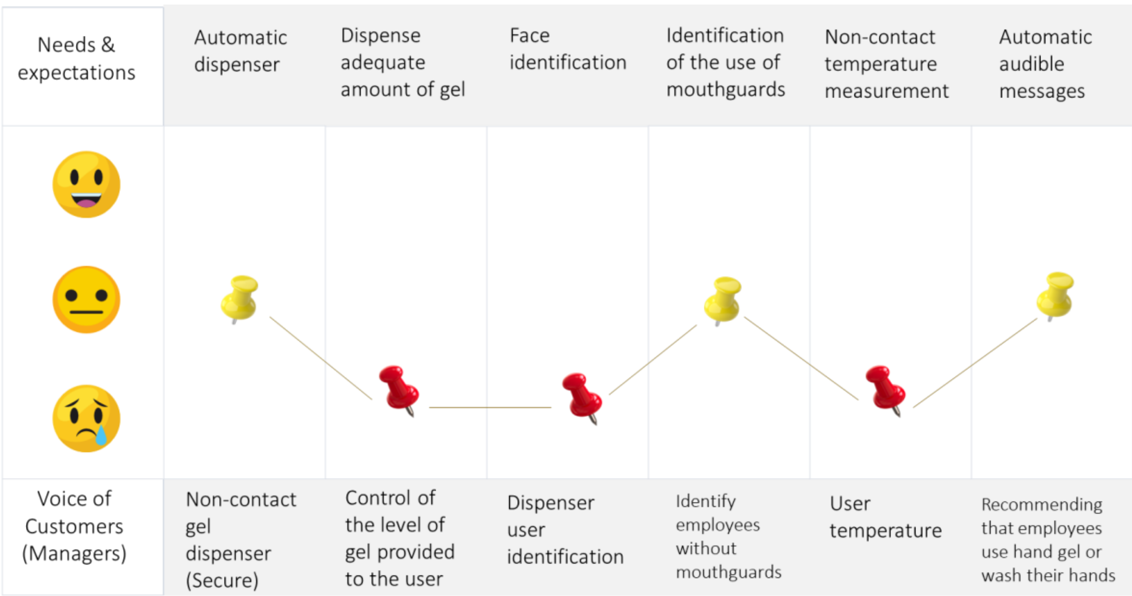

Figure 5: Customer Journey Mapping of the Smart Dispenser

In stage 3, with the help of the tools considered in this stage, the Business Model was developed.

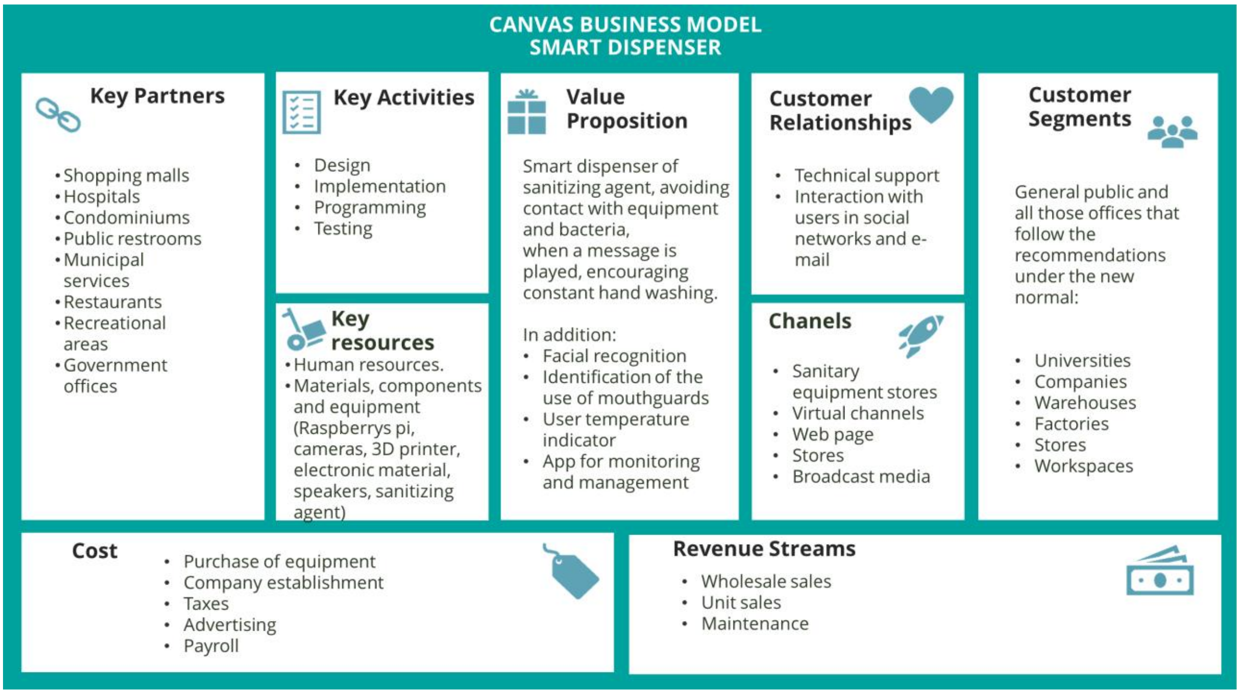

Figure 6: Canvas business model of the Smart Dispenser

In stage 4, with the help of SCAMPER, the characteristics of the prototype were established. Prototyping was developed in stage 5. The prototype is shown in Figure 7.

Figure 7: Prototype and development team

In Stage 6, an expert evaluation was performed, improving the content of your pitch and providing improvement tips for the prototype.

By following each stage of the development of the project, students gain vision from where to align your project to have potential impact, establishing solid development bases, strengthening the knowledge learned in related areas, transferring the application to achieve the solution of a specific problem, and concluding with the soft skills required both in the development itself, as in the presentation of the prototype and the evaluation before the expert committee, not only gaining experience, but resilience and motivation to continue improving. The competitions demonstrate the efficiency of the work performed, as this is where the results of the training received are most evident.

The following subsections provide summaries of the objectives, results, and impact of each of the three remaining projects. Emphasis is placed on the employability achieved by the members of the developer teams in each. Section 4 provides a summary of the dissemination achieved in Stage 7.

3.2. Brief resume of objective, results, and impact of the other three projects

3.2.2. Nounou project

Objective: To design and implement an automatic device that allows the autonomous movement of an infant in a controlled space (Fig. 8).

Results: This project aimed to develop an autonomous walker that would enable parents to attend to other tasks in the house without neglecting their children.

This project also included a mobile application, designed to monitor the walker's location in a controlled space, providing parents with peace of mind.

It is worth mentioning that this project received two international awards at the 2018 International Tournament of Mobile Applications "Tu App," held at the Pontificia Universidad Católica del Perú, for Best Originality and an Honorable Mention (Figure 9).

Figure 8: Participants of the Nounou Project

Figure 9: Obtained awards, Nounou project

Impact: Currently, the two members of this team are working abroad as engineers in Industrial Computer Vision at AESC, a company that manufactures batteries for Nissan. AESC is a world leader in the development and manufacture of high-performance batteries for electric vehicles and energy storage systems. The Company's cutting-edge technology and reliability are enabling and accelerating the transition to clean energy solutions.

3.2.3. Florence Project

Objective: To design and implement a device for serum monitoring and support for hospitalized patients (Fig. 10).

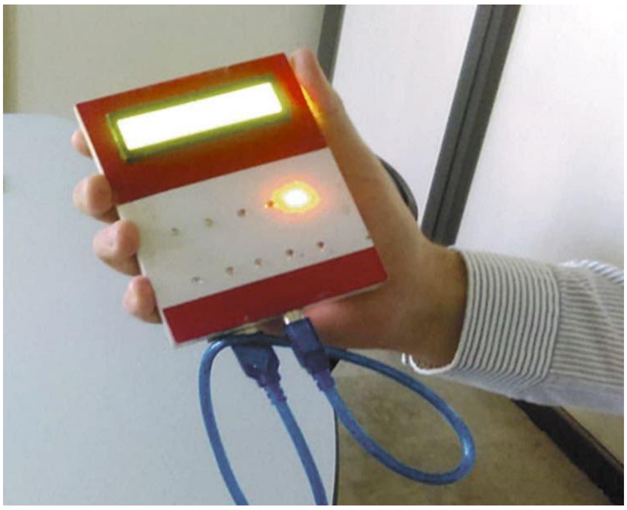

Figure 10: Florence prototype

Results: This project was undertaken to support nurses in their workplace, as the medical staff are currently overwhelmed due to the large number of patients and the shortage of personnel in the health sector. Florence offers an alternative to monitoring the supply of serum to patients throughout the hospital, including responding to patient requests for support.

Impact: Currently, the student who developed this project is working as a Vision Engineer in South Korea. This company is a subsidiary of CSI in South Korea.

3.2.4. Ready Order Project

Objective: To replace companies' printed advertising using portable devices to send digital advertising via Bluetooth (Fig. 11).

Results: With this project, we competed in the international contest "Tu App" 2017 in the city of Ocaña, Colombia. It turned out to be a very striking and innovative project for all the small and medium-sized companies that participated in the Apps fair during this important international event.

Impact: The participating student works for an automation company called Extreme Automation, which serves companies such as Tesla. This company has over 15 years of experience in developing projects and engineering solutions for the Automation of Control Systems and data acquisition systems across various industries, including Chemical, Pharmaceutical, Food, Beverage, Personal Care, Manufacturing, Textile, and Automotive.

3.3. Example of student performance on a stay in a Colombian organization

Objective: To implement a prototype prosthesis printed using 3D printing techniques.

Results: This project was carried out in collaboration with Fabrilab during the students' stay (Fig. 12). Fabrilab is a non-profit organization based in Bogotá, Colombia. This corporation focuses on the development of assistive technology and clinical and community intervention protocols to achieve comprehensive rehabilitation for users.

Impact: After completing their project with Fabrilab Corporation, the two participating students and 7 of their peers joined Sewon America. This is the largest automotive body parts manufacturing plant in North America and has been recognized by customers for its high level of quality, thanks to its automated manufacturing process and efficient logistics. This project was presented at the 2019 Mexican Conference of Mechatronics in the category of Technological Innovation.

Figure 11: Ready Order Project presentation

Figure 12: Participants of the 3D Printed Prosthesis Project.

5 Importance of dissemination of results and networking on employability

In the methodology for the Development of Potentially Innovative Technological Projects, a vital step is dissemination, which is carried out after participation in events. Some of the means used for disseminating the project's results (mentioned in Section 2) are shown in Table 3.

Table 3. Impacts on employability

Project	Dissemination results Media	Impact on employment	Employer´s method of contact	Participation in contests
Smart Dispenser	Printed and online media (Diario de Morelos), Facebook, TV Azteca Morelos, and Televisa	2 students are working at Nissan, one at Baxter, one at Saint Go Bain		Innovation Challenge Track Finals (IEEE region 10), online. From Bangladesh. This event involved around 183 participants from 16 countries. Team obtained a honorable mention
Nounou	Online media (24 Morelos), Facebook	2 members of this team are working abroad as engineers in Industrial Computer Vision at AESC	Facebook and LinkedIn	"Tu App 2018", Pontificia Universidad Católica del Perú, with 120 projects participating. 40 finalists were chosen, obtaining Best Originality and an Honorable Mention
Florence	Printed and online media (Diario de Morelos), Facebook	The student who developed this project is working as a Vision Engineer in South Korea at CSI.		"Tu App" 2018. The team obtained 6th place.
Ready Order	Printed and online media (Diario de Morelos), Facebook	The student works in Extreme Automation, a company devoted to automation.		"Tu App 2017", Colombia. Out of 100, they were ranked among the 30 finalists.

As shown in Table 3, disseminating results is fundamental, as it is one of the most effective ways to make them visible. Social networks, particularly Facebook, as well as printed and online publications, gained support thanks to the backing of the Diario de Morelos. Internet access enables the global dissemination of information, allowing achievements to be shared across various geographical areas and sparking the interest of employers, who find the acquired skills highly relevant to their competitive sectors. Contact with these employers has generally been made through Facebook and the professional networking site LinkedIn. Individual capsules were generated for TV Azteca Morelos, which were broadcast on Facebook, achieving a maximum of approximately 5,000 likes.

It should be noted that these achievements, awards, and now international contracts. However, they are also the result of the work, commitment, and effort of the participating professors and experts. In addition, these achievements also contribute significantly to the prestige of this Mexican institution.

4 Methodology maturity

In 2017, the group of experts began reviewing projects developed in the Integrating Learning Unit. This integration also allowed the methodology to mature in such a way that each stage was complemented as follows:

- Stage 1. Motivation: Presentation of Challenges and Opportunities, complemented with the motivation generated by success stories of their peers.
- Stage 2. Empathize: The last tool added was Customer Journey Mapping, which allowed a more precise identification of the user's expectations.
- Stage 3. Definition: Remained unchanged.

- Stage 4. Ideate: The last tool incorporated was the MKT video, in response to the requirements requested in international competitions.
- Stage 5. Prototyping: The TRL determination was added last, as it is also a common question in competitions.
- Step 6. Expert evaluation: The group of experts, adapted in terms of the profiles that comprised it, initially formed by researchers and entrepreneurs, and later joined by innovation managers, as well as a graduate student in Knowledge Commercialization. On average, the evaluations of the integrative courses have been attended in person since 2017, with a panel of 4 people, initially in person and then virtually due to the COVID-19 pandemic, which remained in place until 2022. This assessment was conducted 4 times per year.
- Stage 7. Dissemination of results: Social networks gradually increased their coverage, becoming a relevant medium.

5 Conclusions

The comprehensive methodology developed and applied, based on the results obtained, has proven to be efficient. Both these results and the changes observed in the team members participating in competitions are very encouraging and highly motivating for their peers. It is worth noting that national and international awards have been received. In addition to those shown here, more examples can be found in [8]. The examples of contracts obtained in companies at an international level increase the motivation of both students and teachers to continue participating in similar competitions.

The improvements in communication skills, leadership, and empowerment obtained are widely valued by employers, as validated by the hires achieved.

On the other hand, internal mobility is an integral part of project development. Participation in international competitions significantly enhances this mobility, enabling students in training to develop intercultural awareness by interacting with people from diverse geographical locations and cultures.

After more than eight years of applying this methodology, new positive results are constantly being added. Therefore, it is desirable to continue its application, without neglecting the updating of the challenges and needs faced, as well as considering the technological trends and new tools available.

On the other hand, it is desirable to have institutional incubators to strengthen projects with higher expectations of commercial success, given their potential for scaling. Additionally, it is desirable to include investors in the panel of experts.

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