Design of Research Internships for Undergraduate Engineering Students: A Framework for Bridging Academia and Industry

Dr. Carlos Sotelo, Tecnologico de Monterrey, School of Engineering and Sciences

Carlos Sotelo is a Research Assistant Professor at Tecnológico de Monterrey. He received his B.S. in Mechatronics Engineering and his M.S. degree in Automation and Control Engineering, the two degrees from Tecnológico de Monterrey, Campus Monterrey, México in 2010 and 2015 respectively. Furthermore, he has received his M.S. degree in Systems, Control and I&T from the Université Joseph Fourier of Grenoble, France in 2014. Finally, in 2019, he received his PhD degree after several publications, he is currently ascribed in the Mobility research group at Tecnológico de Monterrey in Monterrey City, member of the Mexican National Research System SNI-I. His main research interests are nonlinear control, mechatronics, parametric identification and predictive control of refinery processes.

Dr. David Sotelo, Tecnologico de Monterrey, School of Engineering and Sciences

David Sotelo is a Research Assistant Professor at Tecnológico de Monterrey. He received his BS. in Mechatronics Engineering and his MSc. degree in Automation and Control Engineering from Tecnológico de Monterrey, Campus Monterrey, México in 2010 and 2015 respectively. Moreover, in 2014 he has received his MSc. degree in Systems, Control and I&T from the Université Joseph Fourier of Grenoble, France. In 2019, he received his PhD degree with several publications. Nowadays, he is ascribed in the Mobility research group at Tecnológico de Monterrey in Monterrey City, member of the Mexican National Research System SNI-I. His main research interests are optimal and robust control, process identification and design of control structures in crude oil distillation columns.

Carlos Cuadras Santaella, Tecnologico de Monterrey (ITESM)
Iván Enrique Rodríguez, Tecnologico de Monterrey (ITESM)
Dr. Michael Frye, University of the Incarnate Word

Michael Frye, Ph.D. is a Professor of Electrical Engineering in the Department of Engineering at the University of the Incarnate Word, in San Antonio, TX. He is the PI and Director of the Autonomous Vehicle Systems Lab.

RICARDO SWAIN OROPEZA, Tecnologico de Monterrey, School of Engineering and Sciences

Ricardo Swain Oropeza is the Dean of the School of Engineering and Sciences in the Monterrey Region at Tecnológico de Monterrey. With over 24 years of experience at the institution, he has served in key roles as a professor, researcher, curriculum designer, and co-creator of the Tec21 educational model. He is a distinguished member of the National Association of Faculties and Schools of Engineering (ANFEI), where he served as President from 2010 to 2012, and a full academic member of the Mexican Academy of Engineering. He holds a BS in Electronic Systems Engineering from Tecnológico de Monterrey, an MSc and a PhD in Industrial Computing with a specialization in Mobile Robotics from the Institut Polytechnique de Toulouse in France, and completed a postdoctoral fellowship at the University of Illinois at Urbana-Champaign (UIUC) in the United States, participating in a research project sponsored by the U.S. Army.

Luis Eduardo Garza Castañon, Tecnologico de Monterrey, School of Engineering and Sciences

Design of Research Internships for Undergraduate Engineering Students: A Framework for Bridging Academia and Industry

Abstract

In 2019, looking for a life-changing experience in their students, the educational model of Tecnologico de Monterrey in Mexico evolved. Henceforth, the teaching method is currently based on active learning, connected to the real challenges of the environment and enhanced by technology. The academic structure is divided into three main stages: Exploration, Focus, and Specialization. During this last stage, each student designs his own path, choosing among concentrations, internships, and exchanges.

Considering that research in higher education enhances durable skills in students and benefits faculty members of the university, this paper presents how four different proposals of research internships have nurtured research talents and encouraged students to develop their "science identity", when they are exposed to diverse perspectives and experiences at undergraduate level.

The research internship proposals are designed to foster applied research in the field of engineering technology; henceforth, collaborations with state-owned and private enterprises are carried out. Here, partnerships have a key role in students, avoiding the false impression that research is time-wasting. In the research internship titled "Dynamic Simulation of crude oil and gas plants using Aspen – Hysys® in collaboration with PEMEX Exploración y Producción" was aimed to develop an accurate modelling simulation of a crude oil and gas plant using Aspen HYSYS® environment in dynamic mode. Hence, design and sizing equipment for each stage of the processes was described in detail, and a comparison between the simulation results and plant data was carried out. According to the research internship titled "Embedded optimization techniques for multivariable control strategies improvement", the student used MPC and developed his own method to improve the time execution for obstacle avoidance in holonomic robots. Additionally, in the research internship titled "Implementation of Advanced Control Strategies for Unmanned Aerial Vehicles (UAVs)", the student designed and implemented a hierarchical model predictive control (MPC) for three-dimensional trajectory tracking using a quadrotor of Quanser® company. Experimental tests were performed at the laboratory of University of the Incarnate Word in San Antonio, Texas, U.S., supported by, or in part by, the U. S. Army Research Laboratory and the U. S. Army Research Office. Finally, in the research internship titled "Engineering AI Solutions for Early Detection, Prediction, and Prevention of Mental Health Disorders", the student integrated predictive models and machine learning to identify anxiety or depression in the early stage.

The outcomes of these research works are two papers published in indexed journals Q1 in 2024, two conference manuscripts accepted for publication, in the 2025 22nd International Conference on Electrical Engineering, Computing Science and Automatic Control (CCE) and in the Institute for the Future Education (IFE) Conference 2026, and four manuscripts under review in indexed journals Q1/Q2. This, in collaboration with undergraduate students

of different disciplines, faculty members of Mexican and American Universities, engineers of industry partnerships and a member of the psychiatric Mexican conseil. Finally, this contributed to graduating two students of Master programs, enrolling two students in the Master program and two students in the Doctoral program, allowing them to progress in their career path.

Introduction

Higher education worldwide is increasingly adopting active learning, which immerses students in real-world challenges [1]. Here, students learn to apply theoretical knowledge to unstructured problems, manage long-term projects independently, and translate complex findings for diverse audiences [2]. Literature suggests that research internships courses based on active learning have a positive impact, as they foster durable skills in students, including the ability to structure scientific studies, independently execute projects, and apply recognized standards of scientific practice [3]. Similarly, faculty members benefit from enhancing learning and taking advantage of research outcomes, while universities benefit from generated publications or intellectual property (IP), increasing their international rankings and acquisition of Performance-Based Research Funds (PBRF) [4].

However, the full educational impact of research internships is often constrained by factors that limit students' ability to acquire their potential benefits. A well-documented issue is the persistent skill gap between academia and industry, which suggests that undergraduate research opportunities may not prepare students for real-world challenges. This problem involves a lack of practical skills applicable to industry, which can limit students' learning to a primarily theoretical framework [5]. Furthermore, a poorly designed research program with a lack of clear goals can produce difficulties in effectively guiding the student. This has a significant impact on the student's motivation and professional identity, fostering a negative perspective that may separate them from continuing in their respective fields [6][7][8]. Nevertheless, research bibliography indicates meaningful differences between undergraduates who participate in research experiences and those who do not, with such participation being associated with progression to graduate study [9].

Improving the design of the research internship can address the issues mentioned earlier. These include developing an in-depth understanding of a topic, learning how to use appropriate methods and techniques, fostering independent thinking, learning how to interpret data, and improving oral and written communication skills, among others [4]. In addition, aligning with active learning principles and having collaboration with industry partnerships allows students to develop practical skills through projects supervised by the academy [10]. This approach reduces the gap between academy and industry and prepares students for real-world experiences. Moreover, studies have highlighted that well-structured internship programs enhance students' employability by providing them with opportunities to apply theoretical knowledge in practical contexts [11]. These findings suggest that well-designed research internships can yield positive educational outcomes.

In this paper, four different research internship models are proposed, designed to support the development of research talent by enhancing students' learning. Beyond theoretical knowledge acquisition, the aim of these internships is to foster students' science identity, ensuring they can integrate better into the culture of scientific research, find their own science identity within it, and understand the benefits that this entails [12]. Within these experiences, students are positioned as active contributors rather than passive learners, with each contribution supporting skill development, professional growth, and a sense of belonging within the research community, factors commonly associated with academic persistence and progression.

As students strengthen their research competencies and professional identity, the relevance of exposure to authentic industry challenges becomes apparent. Accordingly, collaborations with state-owned enterprises are established, developing other areas that enrich the student experience, such as industry input and academic feedback, communication networking, professionalism, teamwork, and time management [13]. In this sense, partnerships play a key role in students' experiences. Through planning, meetings, and follow-up sessions, the partners can observe the direct progression and struggles that students may have during the ongoing process, all while working with the idea that industry benefits from research.

Background and Institution Context

In Tecnologico de Monterrey at Mexico, the faculty of Engineering and Sciences offers a four-year undergraduate program, which is organized in three phases: exploration, focus and specialization. In the exploration phase, students acquire foundational knowledge in science and engineering, identify their areas of interest and develop key skills. Then, during the focus phase, core disciplinary competencies are consolidated and assessed through advanced academic blocks, hands-on practice and projects. Finally, in the last year of the program, the specialization phase supports advanced technical development while fostering student autonomy, professional identity formation and readiness for post-graduation transitions.

Henceforth, once the student has discovered his main interest in engineering and strengthened his professional competencies, in specialization phase, the student solidifies his impact on the world by the following programs:

> **Studying abroad.** The international program exposes students to different cultures and aims to cultivate leaders capable of competing at an international level.
>
> **Professional internship.** It involves close collaboration with the company to jointly define student's internship work plan. Here, companies serve as disciplinary training

partners, providing students with practical experiences, in which they develop competencies and gain professional background.

Research internship. Students carry out a project proposed by a professor, aligned with the research lines of the faculty. The experience gained by applying the scientific method to a research project within their disciplinary area enables students to enhance their competencies.

Academic minor. It is designed to provide students with knowledge and skills in a discipline that complements their primary field of study or, alternatively, deepens their expertise within their own area of specialization.

Methodology

This article examines the implementation of four senior undergraduate research internships: “Dynamic Simulation of crude oil and gas plants using Aspen – Hysys® in collaboration with PEMEX Exploración y Producción”, “Embedded optimization techniques for multivariable control strategies improvement”, “Implementation of Advanced Control Strategies for Unmanned Aerial Vehicles (UAVs)” and “Engineering AI Solutions for Early Detection, Prediction, and Prevention of Mental Health Disorders”. Figure 1 shows the stages for the design and implementation of the research internship programs.

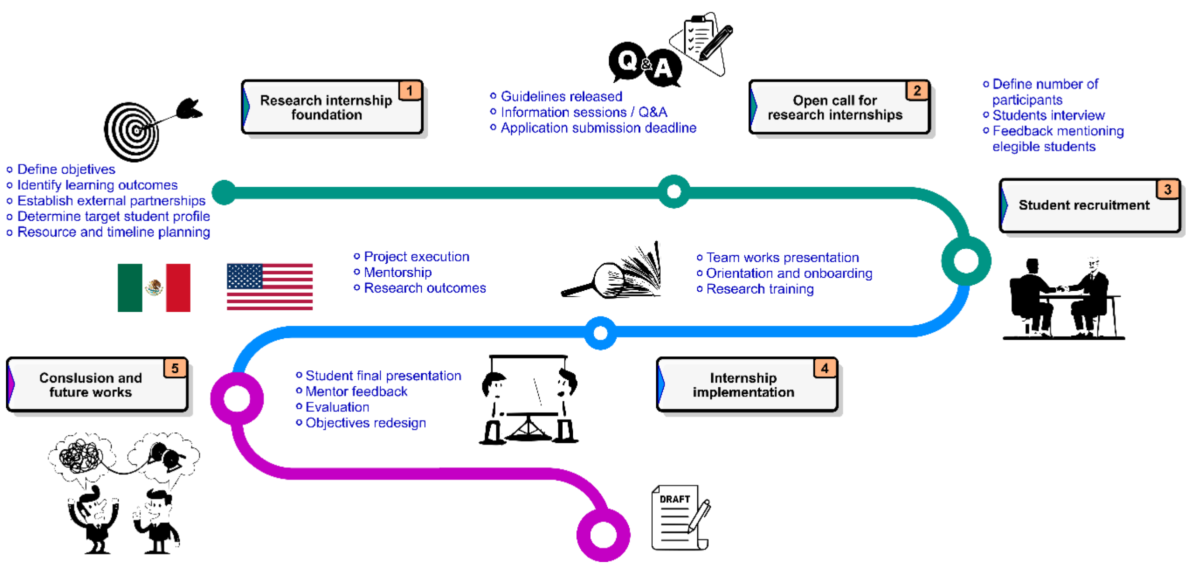


Figure 1. Structure of the research internship program.

Stage 1. Research internship foundation

Define objectives

The research experiences were structured around defined objectives that guide course development and ensure alignment among learning activities, competency-based evidence, and evaluation processes. These objectives emphasize theoretical knowledge, design strategies and hypothesis testing, with implementation of prototypes for real-world challenges. As is mentioned in literature, this approach supports the development of competencies such as critical thinking, problem-solving, leadership, and adaptability [14]. Hence, the course aimed to prepare students for effective participation in control systems research internships by strengthening foundational research, modeling, and analytical skills, while providing opportunities for specialized knowledge acquisition and global networking.

Identify learning outcomes

Student learning outcomes are defined in alignment with the Tec21 educational model, which emphasizes challenge-based and research-oriented learning. These outcomes are assessed through activities, reports, presentations, exams, and a corresponding challenge. The assessment design supports competency development by using evidence generated through activity-based learning, as illustrated in [15]. Within this framework, student performance is evaluated across two categories of competencies: disciplinary competencies, and general education and vision-support competencies. This approach allows the identification, with a reasonable degree of certainty, that students are following an appropriate learning path and enables more effective feedback to strengthen their abilities compared to a traditional course structure.

The following sub-competencies with the corresponding proficiency levels are developed during the Research Internships.

<u>SEG0502 Scientific Thinking</u>

Student addresses problems and questions arising from real-world contexts using valid and reliable methodologies.

Proficiency level: C. Student solves real-world problems and research questions through interdisciplinary scientific research methodologies and projects. These solutions integrate knowledge to identify the different disciplines involved in a given problem; research methodologies and techniques; problem formulation; hypothesis development; preparation of a concise theoretical framework; and methods for reference accreditation. They also include the design and implementation of a plan encompassing techniques, instruments, and procedures for data collection, as well as the processing, analysis, interpretation, and presentation of results from an interdisciplinary perspective.

<u>SEG0503 Critical Thinking</u>

Student evaluates the soundness of one’s own and others’ reasoning by identifying fallacies and contradictions, enabling the formation of an independent judgment in response to a given situation or problem.

Proficiency: C. Student evaluates the soundness of one’s own and others’ reasoning and adopts an individual or collective position on a given issue, fact, situation, or perceived information, based on evidence, valid arguments, and joint analysis conducted by the various disciplines involved. This process integrates knowledge related to the analysis and interpretation of ideas, phenomena, or situations from different perspectives; the importance of rigor and evidence-based objectivity; doubt and inquiry in the re-examination of ideas; analytical and objective perception of diverse human actions; problem-solving and decision-making processes; the advantages of considering alternatives and opposing viewpoints; as well as the conditions required for impartial reasoning.

Establish external partnerships

National and international partners that participate in the projects of the research internships provide industry perspectives and contextual input. This involvement enriches the student experience by introducing authentic problem contexts and real-world perspectives. Similar effects of partner participation in challenge-based learning have been reported in [16]. These partnerships influence the expected outcomes by emphasizing the application of theoretical knowledge, structured problem formulation, and the communication of results within realistic professional or research contexts. Consequently, course activities and outcomes are designed to reflect conditions commonly encountered beyond the academic setting while maintaining alignment with curricular objectives.

Determine target student profile

A critical component of the course design is the definition of a target student profile based on academic background and prior knowledge. As suggested in [17], a set of challenges affects students' preparedness, resulting in lower readiness for research tasks. Therefore, it is important to specify the foundational competencies required for participation in research activities, including core disciplinary knowledge, analytical and problem-solving skills, and familiarity with basic research skills and methods. This profile definition is used to determine the scope and difficulty of research tasks, as well as the appropriate level of guidance and mentoring. As a result, the course structure and expectations are aligned with student readiness, supporting effective participation in the research internship.

Resource and timeline planning

The research internships are structured over a 17–week period, corresponding to approximately 360 hours of student engagement, consistent with semester-long research internship models reported in the literature (15–16 weeks) [18] [19]. The resources and timeline are defined to ensure the successful completion of the research activities and the achievement of the expected outcomes of the course.

Stage 2. Open call for research internships

Guidelines Released

Participation guidelines are defined to specify the intended audience and scope of the research internships. In these programs, eligibility criteria include verification of the student's academic program, completion of at least the seventh semester, and demonstrated interest in participating in a research internship. Similar eligibility criteria have been reported in prior research, where institutions identify students using indicators such as minimum GPA thresholds, strong writing skills, and performance in quantitative coursework [20]. Within this framework, research internships are available to undergraduate students from engineering and science programs, including Bachelor's in Mechatronics Engineering (BME), Bachelor's in Robotics and Digital Systems Engineering (BRDE), Bachelor's in Chemical Engineering (BCQ), and Bachelor's in Innovation and Development Engineering (BIDE). Beyond defining eligibility, the guidelines also established expectations regarding internship duration, level of engagement, and alignment between students' academic backgrounds and the research activities.

Information sessions / Q&A

Information sessions are scheduled to communicate the structure and scope of the research internship of the prospective participants. A total of four sessions is conducted, typically two per month, to provide consistent opportunities for clarification and engagement. During these sessions, students are informed about the internship objectives, title, eligibility criteria, duration, modality (hybrid or remote), and the role of external partners. Additional information included the expected workload, the application of theoretical knowledge within research contexts, links to external organizations, and relevant contact details. These sessions support alignment between student expectations and internship requirements prior to participation.

Application submission deadline

An application submission deadline is established to support the planning and organization of the research internship. This deadline allows for coordination of student selection, the number of participants, required materials, and planning for international experiences or visits to partner institutions, depending on the program. This timeline informs the scheduling of supervision, resource distribution, and the initiation of research activities, contributing to a structured and manageable implementation of the internship.

Stage 3. Student recruitment

Define number of participants

The courses are designed considering five or six undergraduate participants per research internship team. This decision is based on common practice in experiential and project-based learning contexts, where small groups enable active collaboration, distributed responsibility, and a manageable supervisory workload. Evidence from research in the life sciences supports this choice: most research groups are modest in size, averaging around seven members, productivity shows diminishing returns as group size increases, and overall effectiveness is maximized by many small groups rather than fewer large ones [21]. Defining participant numbers within this range allows resource allocation, mentorship capacity, and the organization of research tasks throughout the stay.

Students interview

Student interviews are conducted by Professors and external mentorship as part of the selection and alignment process. These are structured to assess students' readiness, research interests, and alignment with internship expectations. Guiding questions are focused on: (1) reasons for choosing the research internship, (2) prior research experience, and (3) interest in pursuing a postgraduate degree. This interview process informs participant selection and facilitates alignment between student profiles, research projects, and mentorship capacity.

Feedback mentioning eligible students

Feedback is provided to applicants to communicate outcomes and ensure transparency in the research internship process. Eligible students are identified based on predefined evaluation criteria, including academic background, alignment with research objectives, prior exposure to relevant skills, and availability to meet internship requirements. Communicating acceptance or non-acceptance outcomes supports clarity in participant selection and informs subsequent planning, including team formation and mentorship assignment.

Stage 4. Internship implementation

Team works presentation

Once students are selected, formal introductions and organizational activities are conducted to support team-based research, allowing students to identify their assigned teams and begin developing skills such as teamwork, communication, and collaboration. The presentation contributes to the beginning of collaborative work and informs subsequent team coordination and task allocation, supporting alignment between student activities and the defined research goals.

Orientation and onboarding

At the beginning, an orientation session is conducted to communicate the objectives, scope, and expectations of the research project. This onboarding process supports alignment between student activities and the defined research goals.

Research training

Research training is provided before the starting of the course through structured seminars delivered to the enrolled students. The seminars address foundational research skills and points in equal conditions and support consistent preparations across participants.

Project execution

Project execution is structured into defined stages to guide the progression of research activities. These stages support the organization of tasks related to problem definition, literature review, implementation, validation, and documentation, enabling consistent progress and effective monitoring of research development.

Mentorship

Mentorship and supervision are provided throughout the research internship to ensure continuous guidance and oversight. According to [7], inadequate supervision can negatively affect students' motivation and ultimately the quality of their research, highlighting that the supervisor's role is crucial. In these research internships, each team works closely with a partner, and weekly meetings are held with collaborators and supervising professors to review progress and address emerging issues. This supervision model facilitates ongoing monitoring of research development, early identification of technical or conceptual challenges, and timely adjustments to project scope when necessary.

Research outcomes

The research internships are structured to conclude with the development of a manuscript draft by all participating students. Requiring a draft manuscript serves as a unifying research output, guiding project scope, documentation practices, and timelines from the early stages of the internship. Therefore, as proposed in [22], writing an effective manuscript is recognized as a pivotal step in the successful closure of a research project and contributes directly to the academic profile and visibility of the researcher. This outcome-oriented design supports systematic research execution, encourages early consideration of dissemination standards, and aligns student work with practices commonly used in academic and applied research environments, including industry-oriented research contexts.

Stage 5. Conclusion and future works

Student final presentation

A final presentation with partner organizations and professors is conducted by the students to formally communicate their research process, results, and conclusions. Some presentations are delivered outside the university or abroad, depending on whether the experience is national or international. This presentation served as a structured mechanism for evaluating research outcomes and ensuring alignment between the completed work and the defined stay objectives.

Mentor feedback

Mentor feedback is provided at the conclusion of the research internship to document student performance and research outcomes. This feedback corresponds to the final evaluation and supported reflection on the research process and results. Additionally, student feedback is collected through an anonymous survey at the conclusion of the internship to document student satisfaction.

Evaluation

Evaluation is conducted using predefined criteria aligned with the internship objectives and expected research outcomes. The assessment considers research progress, the quality of deliverables, and adherence to defined timelines.

Objectives redesign

The research internships objectives are periodically reviewed and refined to ensure alignment with the project scope, student progress, and partner expectations. This iterative refinement allows the objectives to remain realistic, research-driven, and responsive to emerging constraints and findings.

These research internships are categorized in: National Research Internships and International Research Internships. Hence, for these internships, the foundations, Stage 1, and the implementation, Stage 4, shown in Figure 1, are described below.

National Research Internships

Title: "Dynamic Simulation of crude oil and gas plants using Aspen – Hysys® in collaboration with PEMEX Exploración y Producción"

Since 2022, this research internship has been performed by undergraduate students in collaboration with a state-owned oil company of Mexico. The details are described as follows:

Approach

Considering the lack of a proper simulation, it is aimed to develop a rigor and an accurate modelling simulation of complete crude oil and gas plants using Aspen HYSYS® environment in dynamic mode. Hence, design and sizing equipment for each stage of the processes should be described in detail. Additionally, to prove the accuracy of the developed models, a comparison between the simulation results and plant data must be carried out. Furthermore, model and simulate petrochemical scenarios such as the crude oil distillation, catalytic and gas conditioning processes with the purpose of implementing a conventional control structure that contemplates main disturbance is desirable; this, to obtain products under international quality standards.

Partnership

It is carried out with Petróleos Mexicanos (PEMEX), which is a Mexico's state-owned oil company and one of the largest integrated energy enterprises in Latin America. It was established in 1938 following the nationalization of the country's oil industry. PEMEX has historically held a central role in Mexico's economic development and energy sovereignty. The company operates across the entire hydrocarbons value chain, including exploration and production, refining, petrochemicals, logistics, and commercialization of oil, natural gas and refined products.

Target student profile

This research internship seeks students with knowledge in optimization and advanced control of processes for the dehydration and desalting of Maya crude oil, fuel gas heating and regulation, seawater treatment and injection into reservoirs at offshore facilities operated by the state-owned oil company located in Mexico.

Table 1 summarizes the algorithm followed to implement this research internship.

Table 1. Algorithm for the national research internship implementation with a state-owned oil company

Algorithm 1: Research internship implementation with a state-owned oil company

Input: Engineering student with core disciplinary competencies
Output: Student with hands-on research and petrochemical process experience

Begin

Week = 1 ← *Professors of Tecnologico de Monterrey and PEMEX partnership members are presented with enrolled students*
define Checkpoints ← *Orientation and Onboarding by Professors*

do Seminars **&** Research Bibliography
    Seminars
    Conventional Control ← *Review topics of Modelling, PID Controller Design, Stability Criterion*
    Modern Control ← *Review topics of State-Space Representation, State Gain Matrix K Design*
    Advanced Control ← *Ingredients of MPC, Problem Optimization Definition, MPC Design*
    Research Bibliography
    Petrochemical Processes ← *Search on crude-oil and gas plant processes dynamics*
    Aspen Hysys® Simulations ← *Identify the existing simulations in literature*
    Data ← *Ask the partnership members about available actual data*
    Week = Week + 1
while Week <= 5

for Week **from** 6 **to** 16 **do**
    Project Execution
    Aspen Hysys® Simulations ← *Reproduce existing simulations results*

Control Strategy ← *Propose an advanced control strategy for the crude-oil process*
Implementation ← *Using the actual data, implement the prosed control strategy*
Data Collection ← *Data cleaning and preprocessing is performed prior to analysis*
Analysis ← *Performance comparison of proposed control strategy and actual control structure*
Mentorship and Supervision
Meetings ← *Twice per week with the Professor and once per week with the partnership member*
Feedback ← *According to a weekly report and the meetings*
Week = Week + 1
while Week >= 14 **do**
Manuscript Development
define Journal ← *Search on open access petrochemical indexed journals Q1/Q2*
Research Outcome ← *Write a draft of the manuscript based on own previous publications*
Mentorship and Supervision
Meetings ← *Twice per week with the Professor and once per week with the partnership member*
Feedback ← *According to the draft*
Week = Week + 1
end
end

Final Presentation ← *Carried out during Week 17, Professors and internship members are the jury*

Return Student with hands-on research and petrochemical process experience

---

The main contact here is the Specialist in Automation of Process Control at PEMEX Exploration and Production, and the outcomes are the following:

- 1 research article published in indexed journal Q1 [23],
- 1 research article under review in indexed journal Q2,
- 1 student enrolled in the Master program, and
- 1 student enrolled in the Doctoral program.

Title: "Embedded optimization techniques for multivariable control strategies improvement"

Since 2022, this research internship has been performed by undergraduate students in collaboration with a public higher education and research institution located at Mexico. The details are described as follows:

Approach

Computation complexity makes the multivariable MPC ineffectual for high-speed applications where the controller must execute in a few milliseconds. Moreover, the problem becomes much more complicated solving such an online constrained optimization problem by computing a numerical solver. For this reason, this research internship aims to develop control algorithms to reduce the execution time of constrained optimization problems. Here, strategies are based on advanced multi-input multi-output (MIMO) control design methods, which can be used to meet multiple control objectives. Experimental tests are carried out in the lab, working under different conditions.

Partnership

It is performed with Universidad Autónoma Metropolitana, Unidad Azcapotzalco, which is a public higher education and research institution located in Mexico City, leading public university system in Mexico. It was established in 1974, and it is recognized for its strong emphasis on engineering, as well as for its close interaction with industry and society. Universidad Autónoma Metropolitana promotes innovation, technological development and training of highly qualified professionals and researchers, contributing significantly to scientific advancement and socioeconomic development at the national and international levels.

Target student profile

This research internship seeks students that can do a profiling study of the proposed baseline algorithms and identify the performance bottlenecks. Here, the usage of existing Quadratic Program (QP) solvers is avoided.

Table 2 summarizes the algorithm followed to implement this research internship.

Table 2. Algorithm for the national research internship implementation with a public university

Algorithm 2: Research internship implementation with a public university

Input: Engineering student with core disciplinary competencies
Output: Student with hands-on research and experience in efficient embedded control algorithms
Begin

Week = 1 ← *Professors of Tecnologico de Monterrey and Universidad Autónoma Metropolitana partnership are presented with enrolled students*

define Checkpoints ← *Orientation and Onboarding by Professors*

do Seminars **&** Research Bibliography

Seminars

Conventional Control ← *Review topics of Modelling, PID Controller Design, Stability Criterion*

Modern Control ← *Review topics of State-Space Representation, State Gain Matrix K Design*

Advanced Control ← *Ingredients of MPC, Problem Optimization Definition, MPC Design*

Research Bibliography

Embedded Systems ← *Search on embedded system architectures*

QP Solvers ← *Identify the existing quadratic programming solvers in literature*
Data ← *Ask for available data published in open access manuscripts*
Week = Week + 1
while Week <= 5

for Week **from** 6 **to** 16 **do**
Project Execution
QP Solvers ← *Reproduce existing embedded optimization techniques*
Control Strategy ← *Propose a new software-based optimization technique for embedded latency improvement of a constrained MPC*
Implementation ← *Using required data, implement the prosed software-based optimization technique*
Data Collection ← *Data cleaning and preprocessing is performed prior to analysis*
Analysis ← *Execution time comparison of proposed optimization technique and reported QP Solvers*
Mentorship and Supervision
Meetings ← *Twice per week with the Professor and once per week with the partnership member*
Feedback ← *According to a weekly report and the meetings*
Week = Week + 1
while Week >= 14 **do**
Manuscript Development
define Journal ← *Search on open access embedded systems indexed journals Q1/Q2*
Research Outcome ← *Write a draft of the manuscript based on own previous publications*
Mentorship and Supervision
Meetings ← *Twice per week with the Professor and once per week with the partnership member*
Feedback ← *According to the draft*
Week = Week + 1
end
end

Final Presentation ← *Carried out during Week 17, Professors and internship members are the jury*

Return Student with hands-on research and experience in efficient embedded control algorithms

---

The main contact is a prestigious research professor at the Universidad Autónoma Metropolitana, and the outcomes are the following:

- 1 conference article published in indexed database IEEE Xplore [24],
- 1 student enrolled in the Doctoral program, and
- 1 student graduated from the Master program [25].

International Research Internships

Title: “Implementation of Advanced Control Strategies for Unmanned Aerial Vehicles (UAVs)”

Since 2022, this research internship has been performed by undergraduate students in collaboration with a private university located at the United States. The details are described as follows:

Approach

In recent years, the use of Unmanned Aerial Vehicles (UAVs) technology has notably increased. For this reason, they are used in aerial surveillance, shipping, emergency situations, entertainment shows, and agriculture monitoring, among other areas. These applications require the quadrotors to be fast, agile, and lightweight to be capable of following precise trajectories in the presence of external disturbances. Thus, considering the high coupling between the position and the orientation dynamics, students must design and implement a hierarchical model predictive control (MPC) for three-dimensional trajectory tracking using a quadrotor of Quanser® company. Real-world experiments must be carried out, and improvements of existing control strategies have to be addressed.

Partnership

This research internship is carried out with the Autonomous Vehicle Systems (AVS) Lab of University of the Incarnate Word located in San Antonio, Texas, U.S. This laboratory is supported by, or in part by, the U. S. Army Research Laboratory and the U. S. Army Research Office. The research is closely aligned with the operational needs of CPS Energy, which is the municipally owned electric utility serving San Antonio, Texas, and its surrounding areas. For this reason, in the laboratory, 3D maps have been generated from images captured during multiple Unmanned Aerial System (UAS) flights, and software has been developed to automatically detect powerline components using artificial intelligence techniques.

Target student profile

This research internship targets students capable of developing advanced control strategies for autonomous navigation in both indoor and outdoor environments. Accordingly, a thorough understanding of Unmanned Aerial Vehicle (UAV) dynamics is required, along with the ability to identify and manage manipulation and process variables.

Table 3 summarizes the algorithm followed to implement this research internship.

Table 3. Algorithm for the international research internship implementation with a private university located at the United States

---

Algorithm 3: Research internship implementation with a private university located at the United States

---

Input: Engineering student with core disciplinary competencies
Output: Student with hands-on research and experience in developing advanced control strategies for AVS
Begin

Week = 1 ← *Professors of Tecnologico de Monterrey and University of the Incarnate Word partnership are presented with enrolled students*

define Checkpoints ← *Orientation and Onboarding by Professors*

do Seminars **&** Research Bibliography

Seminars

Conventional Control ← *Review topics of Modelling, PID Controller Design, Stability Criterion*

Modern Control ← *Review topics of State-Space Representation, State Gain Matrix K Design*

Advanced Control ← *Ingredients of MPC, Problem Optimization Definition, MPC Design*

Research Bibliography

Vehicle Control ← *Search on vehicle control structures for three-dimensional trajectory tracking*

MPC ← *Identify the existing MPC strategies real-time implemented for AVS*

Data ← *Ask for available data published in open access manuscripts*

Week = Week + 1

while Week <= 5

for Week **from** 6 **to** 16 **do**

Project Execution

Vehicle Control ← *Reproduce existing vehicle control structures for three-dimensional trajectory tracking*

MPC ← *Design a new MPC architecture for AVS*

Implementation ← *Using the required data, simulate the process under proposed MPC architecture. Then implement it in real-time in the lab to obtain the own data*

Data Collection ← *Data cleaning and preprocessing is performed prior to analysis*

Analysis ← *Performance comparison of designed MPC architecture and existing vehicle control structures*

Mentorship and Supervision

Meetings ← *Twice per week with the Professor and once per week with the partnership member*

Feedback ← *According to a weekly report and the meetings*

Week = Week + 1

while Week >= 14 **do**

Manuscript Development

define Journal ← *Search on open access AVS control indexed journals Q1/Q2*

Research Outcome ← *Write a draft of the manuscript based on own previous publications*
Mentorship and Supervision
Meetings ← *Twice per week with the Professor and once per week with the partnership member*
Feedback ← *According to the draft*
Week = Week + 1
end
end

Final Presentation ← *Carried out during Week 17, Professors and internship members are the jury*

Return Student with hands-on research and experience in developing advanced control strategies for AVS

This research internship strengthens the collaboration with the Director of the Engineering faculty at University of the Incarnate Word in San Antonio, Texas, U.S., making it sustainable. The outcomes are the following:

- 1 research article published in indexed journal Q1 [26]
- 2 research articles under review in indexed journals Q1
- 1 student enrolled in the Master program, and
- 1 student graduated from the Master program [27].

Title: "Engineering AI Solutions for Early Detection, Prediction, and Prevention of Mental Health Disorders"

Since 2025, this research internship has been performed by undergraduate students in collaboration with a private medical clinic in charge of a recognized international psychiatric. The details are described as follows:

Approach

Mental health disorders, a pressing global challenge, have far-reaching impacts that extend beyond individuals to their families and the societies they inhabit. Anxiety involves ongoing feelings of fear, worry, restlessness, and tension, these symptoms can become overwhelming and interfere with all areas of a person's life. In this research internship, the integration of predictive models as a support for improved clinical decision-making and early intervention planning is desired. Tailored treatments based on the individual's conditions, risk profile, and expected development will optimize mental health care delivery and improve outcomes for the prevention of cognitive diseases. Moreover, the evaluation of the performance of a predictive model that uses wearable physiological data to identify signs of anxiety is carried out.

Partnership

This research internship is carried out with a medical clinic that provides psychotherapy, specializing in the treatment of depression, anxiety, bipolar disorder, and schizophrenia. These conditions are addressed by a recognized medical doctor graduated from Harvard University. He uses cognitive-behavioral therapy (CBT), complemented when appropriate with psychopharmacological interventions.

Target Student Profile

This research internship targets students capable of using programming and predictive models to enhance clinical decision-making and support effective early intervention planning. Thus, development of an embedded platform, testing under different conditions and comparison of the results against well-known techniques are required.

Table 4 summarizes the algorithm followed to implement this research internship.

Table 4. Algorithm for the international research internship implementation with a private medical clinic in charge of a recognized international psychiatric

Algorithm 4: Research internship implementation with a private medical clinic in charge of a recognized international psychiatric

Input: Engineering student with core disciplinary competencies
Output: Student capable of using programming and predictive models to enhance clinical decision-making and support effective early intervention planning
Begin

Week = 1 ← *Professors of Tecnologico de Monterrey and private medical clinic partnership are presented with enrolled students*

define Checkpoints ← *Orientation and Onboarding by Professors*

do Seminars **&** Research Bibliography
  Seminars
  Conventional Control ← *Review topics of Modelling, PID Controller Design, Stability Criterion*
  Modern Control ← *Review topics of State-Space Representation, State Gain Matrix K Design*
  Advanced Control ← *Ingredients of MPC, Problem Optimization Definition, MPC Design*
  Research Bibliography
  Mental Health ← *Search on mental health disorders, specifically anxiety characteristics*
  AI Solutions ← *Identify the existing wearable devices and codes used to diagnose and treat mental health disorders*
  Data ← *Ask for available data published in open access manuscripts*
  Week = Week + 1
while Week <= 5

for Week **from** 6 **to** 16 **do**

Project Execution
AI Solutions ← *Reproduce results obtained in literature by using the codes implemented to diagnose and treat mental health disorders and the data required*
Predictive Model ← *Propose an AI solution based on a predictive model to be implemented in wearable devices*
Implementation ← *Carry out a special session to collect own data and implement the proposed predictive model*
Data Collection ← *Data cleaning and preprocessing is performed prior to analysis*
Analysis ← *Performance comparison of the proposed predictive model and existing AI solutions when own data is used*
Mentorship and Supervision
Meetings ← *Twice per week with the Professor and once per week with the partnership member*
Feedback ← *According to a weekly report and the meetings*
Week = Week + 1
while Week >= 14 **do**
Manuscript Development
define Journal ← *Search on open access AI solutions for mental health indexed journals Q1/Q2*
Research Outcome ← *Write a draft of the manuscript based on own previous publications*
Mentorship and Supervision
Meetings ← *Twice per week with the Professor and once per week with the partnership member*
Feedback ← *According to the draft*
Week = Week + 1
end
end

Final Presentation ← *Carried out during Week 17, Professors and internship members are the jury*

Return Student capable of using programming and predictive models to enhance clinical decision-making and support effective early intervention planning

---

This research internship strengthens the collaboration with the Director of medical clinic. The outcomes are the following:

- 1 conference article accepted in indexed database Springer,
- 1 research article under review in indexed journal Q1, and
- 1 student to be enrolled in the Master program.

Service Quality Results

Considering educational services are still far from easy assessment and measurement [28], in this section SERVQUAL instrument is implemented among 22 students (mean age: 22.682 years old, SD: 1.171). Furthermore, a statistical analysis is carried out, and a correlation matrix is computed to identify core satisfaction items for both kinds of research internships.

Implementation of Instrument: Data Collection and Results

The Likert (1-7) scale SERVQUAL survey consists of 15 questions useful to identify the degree of satisfaction of students in research internships [29]. Table 5 shows the questions and the corresponding aspects to be assessed.

Table 5. Questions and the corresponding aspects.

	Question	Aspects
Q1.	The study material recommended by the teacher (texts, notes, articles) is well related to the content of the course	Adequate supplies
Q2.	The teacher's explanations correspond to the course objectives	Verbal explanations
Q3.	The contents of the course were presented and organized by the teacher at the beginning of the course	Content organization
Q4.	The teacher provides clear and well-defined criteria for evaluation and assessment	Well-defined and reliability explained criteria
Q5.	The teacher prepares the classes well	Preparation of classes
Q6.	The teacher takes interest in the students' progress	Focus on the students' learning process
Q7.	The relationship between teacher and students is good	Developing an appropriate teacher student environment
Q8.	The teacher is punctual and keeps to the timetable	Complying with timetables and deadlines
Q9.	I would like to take other courses with this teacher	Trust in the teaching staff
Q10.	My general rating of the teaching is good	Capacity of the teaching staff
Q11.	My overall assessment of the course is positive	Ranking the teaching staff
Q12.	The teacher makes the classes interesting	Interesting classes
Q13.	The teacher is receptive to our suggestions and questions	Receptive attitude
Q14.	The methods used by the teacher facilitate the understanding of the subject matter	Facilitating comprehension
Q15.	The teacher encourages students to participate in class	Encouraging participation

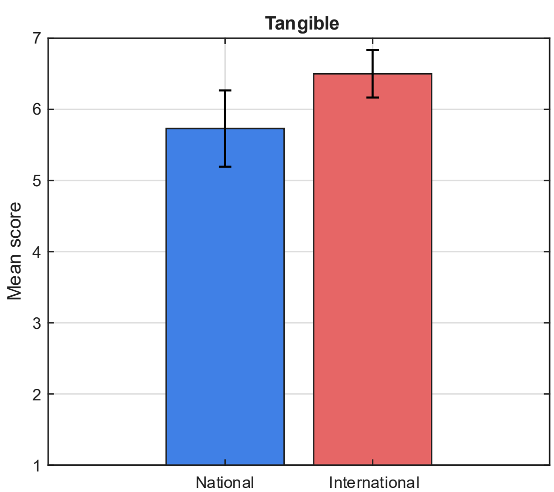
Then, the service quality regards to the Professor performance is grouped into the following five domains to be analyzed:

1. **Tangible.** Evaluated from Q1 to Q2, this domain describes learners´ degree of satisfaction with infrastructure, supplies and verbal tutors´ explanations.

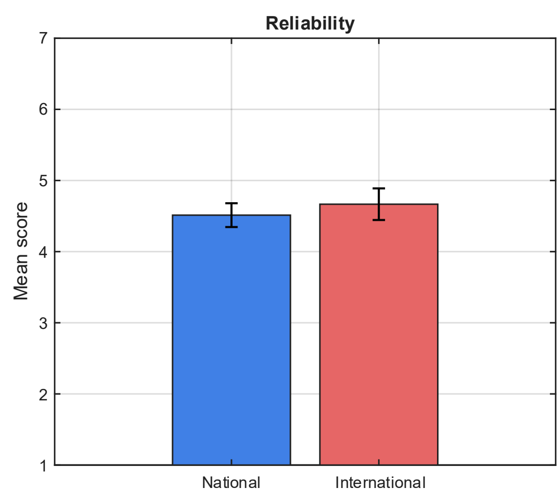
2. **Reliability.** Determined from Q3 to Q5, in this domain, it is possible to analyze if the research internship meets student´s expectations related to content organization, well defined suggested criteria and quality of preparation of the class.
3. **Responsiveness.** Assessed from Q6 to Q8, the domain examines the performance of the Professor regarding classroom environment, punctuality and timetable adherence.
4. **Assurance.** Measured from Q9 to Q11, this domain reflects the Professors´ knowledge and attitudes perceived by students to inspire trust and confidence.
5. **Empathy.** Identified from Q12 to Q15, this domain explores the ability of the Professor to enhance an interesting course promoting an engaging, respectful, and supportive learning environment.

The cleaned datasets were uploaded to Google Cloud and subsequently accessed through Google Colab. Henceforth, the analysis is conducted using Python libraries such as pandas, for data manipulation, NumPy, for statistical analysis, and matplotlib, for data visualization.

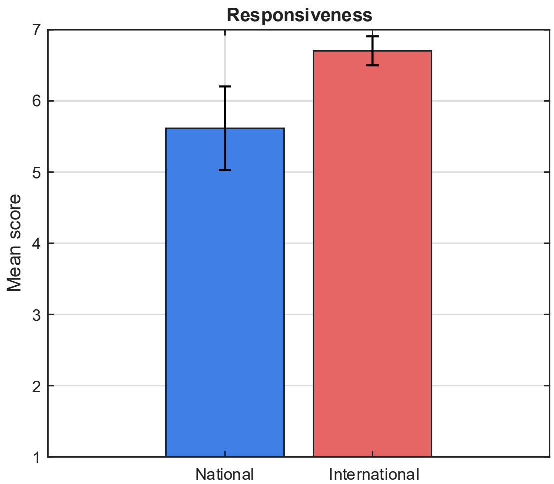
Thus, Figure 2 shows the Mean (M) results and Standard Deviation (SD) for the five domains when research internships are considered independently, nationally and internationally. As observed, for national research internships, students ranked assurance as the most significant domain (M=5.744, SD=1.94) followed by tangible (M=5.731, SD=1.932), empathy (M=5.712, SD=2.036), responsiveness (M=5.615, SD=2.121) and lastly reliability (M=4.513, SD=0.603). On the other hand, for international research internships, students ranked empathy as the most significant domain (M=6.889, SD=0.253) followed by assurance (M=6.852, SD=0.444), responsiveness (M=6.704, SD=0.611), tangible (M=6.5, SD=1.0) and lastly reliability (M=4.667, SD=0.667). It is worth noting that the level of satisfaction is high for both national and international research internships.



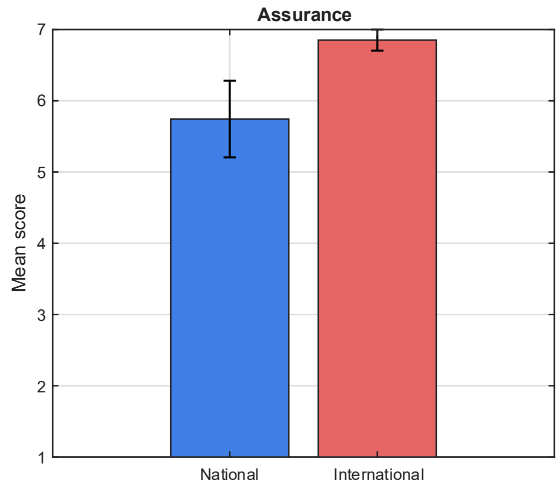
a) Tangible domain



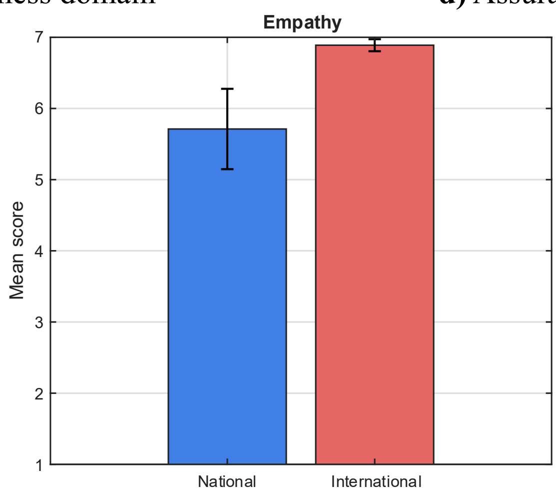
b) Reliability domain



c) Responsiveness domain



d) Assurance domain



e) Empathy domain

Figure 2. Thematic sections mean scores for national and international research internships.

Assessment and Analysis of Overall Satisfaction

Considering both groups of research internships, the scale reliability of the five domains presented in previous section is assessed using Cronbach's alpha, Eq. 1

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum_{i=1}^{k} \mathrm{Var}(X_i)}{\mathrm{Var}\left(\sum_{i=1}^{k} X_i\right)}\right) \tag{1}$$

were α denotes the domain, k stands for the number of question needed to compute the domain, $\mathrm{Var}(X_i)$ is the variance of the i^{th} question X_i, and $\mathrm{Var}\left(\sum_{i=1}^{k} X_i\right)$ is needed to obtain the sum of the variance for all individual items. For instance, if $\alpha \geq 0.9$, suggests excellent reliability, if $0.8 \leq \alpha < 0.9$, indicates good reliability, if $0.7 \leq \alpha < 0.8$, indicates acceptable reliability, if $\alpha < 0.7$, suggests low reliability [28]. Henceforth, results are presented in Table 6:

Table 6. Cronbach's alpha values for scale reliability analysis in domains.

Domain	Cronbach's alpha
Tangible	0.9532
Reliability	0.9587
Responsiveness	0.9701
Assurance	0.9716
Empathy	0.9773

Then, all the domains present excellent reliability, which indicates that the measurement scale has optimal internal consistency [30]. Figure 3 presents the correlation matrix heatmap to analyze in detail the internal consistency among satisfaction related domain and aspects mentioned in Table 5. The analysis revealed consistently strong positive correlations across the fifteen core variables, which indicates structural coherence within the satisfaction construct.

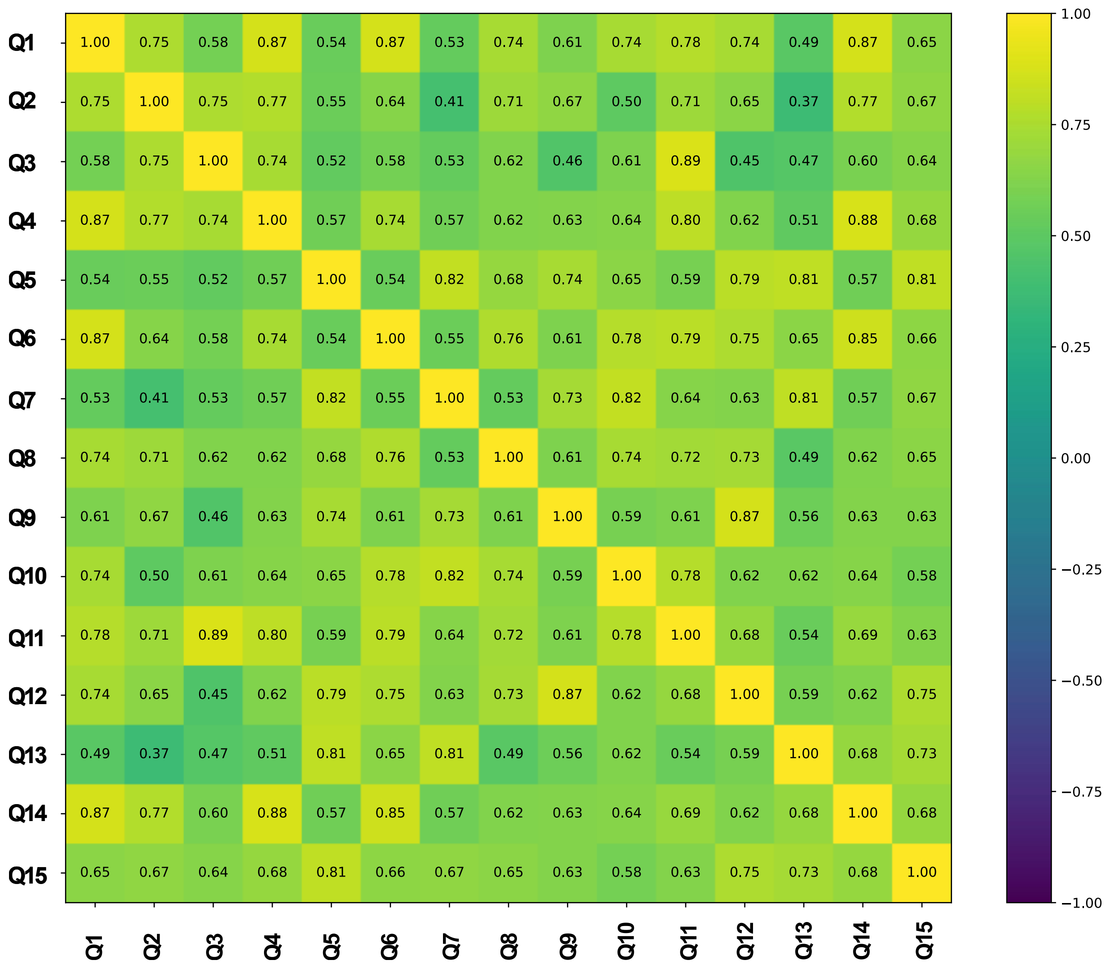


Figure 3. Correlation matrix heatmap of core satisfaction aspects.

Notably the strongest correlation is observed between “The contents of the course were presented and organized by the teacher at the beginning of the course ” and “My overall assessment of the course is positive” $(r = 0.89)$, which suggests that the Professor’s professionalism plays an important role for a good Professor´s performance ranking. Similarly, also “The teacher provides clear and well-defined criteria for evaluation and assessment” and “The methods used by the teacher facilitate the understanding of the subject matter” demonstrate high intercorrelation $(r = 0.88)$, reflecting that the tutor is interested in defining all the criteria to be evaluated and seeking to facilitate the comprehension of the concepts. In fact, the question, “The study material recommended by the teacher (texts, notes, articles) is well related to the content of the course” is intercorrelated with “The methods used by the teacher facilitate the understanding of the subject matter”, “The teacher provides clear and well-defined criteria for evaluation and assessment” and “The teacher takes interest in the students’ progress”, presenting intercorrelation of $(r = 0.87)$, which guarantee an excellent learning experience. This is also corroborated with questions “I would like to take other courses with this teacher” and “The teacher makes the classes interesting”, which have a similar intercorrelation $(r = 0.87)$.

Conclusion

This article examines the implementation of four senior undergraduate research internships. These research internships are categorized in: National Research Internships and International Research Internships. The national research internship titled “Dynamic Simulation of crude oil and gas plants using Aspen – Hysys® in collaboration with PEMEX Exploración y Producción” is strictly professional and scientific in nature, with no financial remuneration involved beyond the generation of scientific output and the professional satisfaction derived from achieving the research objectives. The main contact is the specialist in automation of process control at PEMEX Exploration and Production. Additionally, in the national research internship titled “Embedded optimization techniques for multivariable control strategies improvement”, the students propose and embed control algorithms for a wide range of applications, such as aeronautical scenarios, which is a great industrial and research experience. The main contact is a prestigious research professor of Universidad Autónoma Metropolitana, Unidad Azcapotzalco. Meanwhile, in the international research internship named “Implementation of Advanced Control Strategies for Unmanned Aerial Vehicles (UAVs)”, students propose advanced control strategies and validate them in real-world context, demonstrating the ability of the quadrotor to fly in automatic mode. Here, complex scenarios are selected, considering that they are commonly used as a standard benchmark for tracking control. This research internship strengthens the collaboration with the Director of the Engineering faculty at University of the Incarnate Word in San Antonio, Texas, U.S., making it sustainable. Moreover, in the international research internship called “Engineering AI Solutions for Early Detection, Prediction, and Prevention of Mental Health Disorders”, the students develop algorithms to identify mental illness, such as anxiety, by forecasting individual trajectories of mental health outcomes using AI-aided mechanisms, which impacts on an actual worldwide problem. This research internship strengthens the collaboration with the Director of medical clinic. Thus, according to the collaboration with state-owned and private enterprises, these research internships nurture research talents and encourage students to apply research in the field of engineering technology, when they are exposed to diverse perspectives and experiences at undergraduate level.

Acknowledgments

The authors would like to acknowledge the financial support of Writing Lab, Institute for the Future Education, Tecnologico de Monterrey, Mexico, in the production of this work. Also, the use of the Intelligent Control Lab and all the support provided by the Regional Dean of the School of Engineering and Sciences is appreciated.

References

[1] S. E. Gallagher and T. Savage, "Challenge-based learning in higher education: an exploratory literature review," *Teaching in Higher Education*, vol. 28, no. 6, pp. 1135–1157, 2023.

[2] V. Robledo-Rella, L. Neri, R. M. G. García-Castelán, A. Gonzalez-Nucamendi, J. Valverde-Rebaza, and J. Noguez, "A comparative study of a new challenge-based learning model for engineering majors," *Front. Educ.*, vol. 10, Art. no. 1545071, 2025.

[3] D. L. Rieg, R. M. Lima, D. Mesquita, F. C. L. Scramim, and O. Mattasoglio Neto, "Active learning strategies to develop research competences in engineering education," *J. Appl. Res. High. Educ.*, vol. 14, no. 3, pp. 1210–1223, 2022.

[4] M. Seifan, N. Lal, and A. Berenjian, "Effect of undergraduate research on students' learning and engagement," *Int. J. Mech. Eng. Educ.*, vol. 50, no. 2, pp. 326–348, 2021.

[5] R. Akash and V. Suganya, "Bridging the gap between industry needs and student skills for quality education through SDGs: An industry–academia collaboration in curriculum development," *Jlsdgr*, vol. 4, no. 4, p. e03616, Nov. 2024.

[6] F. Wang, "The impact of internship experience on professional identity, motivation, and attitude among aviation service majors: a cross-sectional empirical study," *Front. Psychol.*, vol. 16, Art. no. 1661068, Nov. 2025.

[7] A. S. Clarin, M. A. G. Barosa, C. D. A. Suico, J. S. Bazar, R. P. Galindo, and G. R. Baluyos, "Challenges encountered by college students in research," *EduLine: J. Educ. Learn. Innov.*, vol. 5, no. 2, pp. 219–239, Mar. 2025.

[8] M. T. Hora, Z. Chen, E. Parrott, and P. Her, "Problematizing college internships: Exploring issues with access, program design and developmental outcomes," *Int. J. Work-Integr. Learn.*, vol. 21, no. 3, pp. 235–252, 2020.

[9] D. Chamely-Wiik, A. Ambrosio, T. N. Baker, A. Ghannes, and J. Soberon, "The impact of undergraduate research experience intensity on measures of student success," *J. Scholarship Teach. Learn.*, vol. 23, no. 1, pp. 14–30, 2023.

[10] F. A. A. Kwa, C. Lloyd, and S. L. Grant, "A scaffolded work-integrated learning model in a health science undergraduate degree: A sequential approach to industry partner engagement," *Int. J. Work-Integr. Learn.*, vol. 26, no. 4, pp. 735–749, Nov. 2025.

[11] H. Gutiérrez-Pulido and C. Orozco-Rodríguez, "The contribution of professional internships to the academic development of engineering and science students: a case study," *Front. Educ.*, vol. 10, Art. no. 1563361, 2025.

[12] Y. A. Levites Strekalova, R. Liu-Galvin, S. Border, S. Midence, M. Khan, M. VanZanten, J. Tomaszewski, S. Jain, and P. Sarder, "Summer research internship curriculum to promote self-efficacy, researcher identity, and peer-to-peer learning: Retrospective cohort study," *JMIR Form. Res.*, vol. 9, Art. no. e54167, 2025.

[13] V. Aggarwal and V. Mishra, "Aligning internship outcomes with SDG 4: A comparative study of academic institutions and industry sectors' expectations," *Int. J. Econ. Perspect.*, vol. 18, no. 10, pp. 1702–1717, Oct. 2024.

[14] J. Membrillo-Hernández and R. García-García, "Challenge-based learning (CBL) in engineering: Which evaluation instruments are best suited to evaluate CBL experiences?," in Proc. 2020 IEEE Global Eng. Educ. Conf. (EDUCON), Porto, Portugal, 2020, pp. 885–893.

[15] J. Membrillo-Hernández, M. de J. Ramírez-Cadena, C. Caballero-Valdés, R. Ganem-Corvera, R. Bustamante-Bello, J. A. B. Ordoñez-Díaz, and H. Elizalde-Siller, "Challenge-based learning: The case of sustainable development engineering at the Tecnologico de Monterrey, Mexico City Campus," *Int. J. Eng. Pedagog.,* vol. 8, no. 3, pp. 137–144, 2018.

[16] A. van den Beemt, P. Vázquez-Villegas, S. Gómez Puente, F. O'Riordan, C. Gormley, F.-K. Chiang, C. Leng, P. Caratozzolo, G. Zavala, and J. Membrillo-Hernández, "Taking the challenge: An exploratory study of the challenge-based learning context in higher education institutions across three different continents," *Educ. Sci.*, vol. 13, no. 3, Art. no. 234, 2023.

[17] R. C. Yodico, "Students' readiness in conducting research: Basis for an intervention plan," *Commun. Appl. Nonlinear Anal.*, vol. 32, no. 10S, pp. 920–940, 2025.

[18] E. Sun, M. L. Graves, and D. C. Oliver, "Propelling a course-based undergraduate research experience using an open-access online undergraduate research journal," *Front. Microbiol.*, vol. 11, p. 589025, 2020.

[19] N. Galeano, R. Morales-Menéndez, and F. J. Cantú, "Developing research skills in undergraduate students through an internship program in research and innovation," *Int. J. Eng. Educ.*, vol. 28, no. 1, pp. 48–56, 2012.

[20] G. Hochman and Y. Jin, "Engaging undergraduate students in research: From cross-discipline programs to published articles," *Appl. Econ. Teach. Resour.*, vol. 7, no. 1, Mar. 2025.

[21] I. Cook, S. Grange, and A. Eyre-Walker, "Research groups: How big should they be?," *PeerJ*, vol. 3, Art. no. e989, 2015.

[22] S. S. Aga and S. Nissar, "Essential guide to manuscript writing for academic dummies: An editor's perspective," *Biochem. Res. Int.*, vol. 2022, Art. no. 1492058, 2022.

[23] R. Valdés, C. Sotelo, F. Muñoz-Torres, A. Favela-Contreras, E. Cruz, and D. Sotelo, "Dynamic simulation of an oil and gas plant using Aspen-HYSYS®: A real start-up process," *Arab. J. Sci. Eng.*, vol. 50, pp. 4599–4611, 2025.

[24] D. L. Hernández, C. Sotelo, A. Favela-Contreras, F. Beltran-Carbajal and D. Sotelo, "Proximal Gradient-Based Model Predictive Control for Obstacle Avoidance in Holonomic Robots," 2025 22nd International Conference on Electrical Engineering, Computing Science and Automatic Control (CCE), Mexico City, Mexico, 2025, pp. 1-6.

[25] A. Abascal Molina, "Monocular obstacle avoidance framework for autonomous navigation," M.S. thesis, Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM), 2025. [Online]. Available: https://hdl.handle.net/11285/703875

[26] P. Borbolla-Burillo, D. Sotelo, M. Frye, L. E. Garza-Castañón, L. Juárez-Moreno, and C. Sotelo, "Design and real-time implementation of a cascaded model predictive control architecture for unmanned aerial vehicles," *Math.*, vol. 12, no. 5, p. 739, 2024.

[27] P. Borbolla Burillo, "Design and implementation of a cascaded MPC with a dynamic battery-aware auxiliary reference for unmanned aerial vehicles," M.S. thesis, Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM), 2025. [Online]. Available: https://hdl.handle.net/11285/703834.

[28] A. Guillén Perales, F. Liébana-Cabanillas, J. Sánchez-Fernández, and L. J. Herrera, "Assessing university students' perception of academic quality using machine learning," *Appl. Comput. Inform.*, vol. 20, no. 1–2, pp. 20–34, 2024.

[29] A. Parasuraman, V. A. Zeithaml, and L. L. Berry, "SERVQUAL: A multiple-item scale for measuring consumer perceptions of service quality," *J. Retailing*, vol. 64, no. 1, pp. 12–40, 1988.

[30] Malhotra NK. Investigacion de Mercados. Un enfoque practico. 2nd ed. Mexico: Pearson Educacion; 1997, ISBN: 9789688808443.