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Developing transversal (soft) competencies in Higher Education Engineering students: the role of the Training Partners in the challenge-based learning model

M. Ileana Ruiz-Cantisani[1], PhD, Vianney Lara-Prieto, PhD[1,2], Rebeca María García and Jorge Membrillo-Hernández, PhD,[2]

[1,] School of Engineering and Sciences, Tecnologico de Monterrey, Mexico, miruiz@tec.mx, rebeca.garcia.garcia@tec.mx

[2] Institute for the Future of Education, Tecnologico de Monterrey, Mexico, vianney.lara@tec.mx, jmembrillo@tec.mx

Abstract*–Current education is based on the development of skills that allow students to face an increasingly global and challenging world. One of the most used active learning strategies is Challenge Based Learning (CBL) with the participation of a training partner, which, combined with the educational model, exposes students to real situations that serve as challenges for the development of hard and soft skills necessary for rapid employment integration. In this report, we investigate the role of these training partners in a university institution of higher education that has CBL as its educational model. The training partners studied were companies, and civil or government organizations. We study the role of stakeholders in the development of transversal (soft) and personal competencies in engineering students, using a mixed research methodology, with surveys and interviews, as well as the results of the development of hard skills. The results point to enhance the level of development of soft skills and create an interesting space for reflection by stakeholders for the implementation of solutions to the challenges studied. The soft skills acquired through the interaction with a training partner reinforce those learned in the educational facilities, however the level of development and complexity such as collaborative work, written and oral skills as well as critical thinking, and complex reasoning were clearly higher. But the most appreciated thing is that the involvement of a training partner allows the students to experience a real work environment. A real-life challenge resolution situation. It is important to highlight that the teachers in charge of CBL must have professional preparation to monitor these competencies developed with the training partners.

Keywords*-- Educational Innovation, Higher Education, Educational Partners, Challenge-Based Learning, Competencies.

I. Introduction

The new educational models of higher education respond to the requirement of having professionals prepared for global challenges and sensitive to an increasingly changing environment. Competency-based education has had its greatest splendor in the development of active education, which seeks to integrate knowledge, attitudes and skills into a real context so that the student has a systemic vision of the world [1,2].

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This educational model necessarily integrates in its design the perspective of multiple actors, not only academics, but also stakeholders such as companies, government, society, which make it possible to bring education closer to real situations in which the student must be immersed to understand the context and propose solutions or improvements according to their disciplines and training. This is the fundamental basis of Challenge Based Learning (CBL), a process where active learning has sought to develop students with critical thinking, autonomy, with knowledge and skills that apply in the real world, and that inspire and engage them in a constant learning in all environments [3,4,5].

For the development of skills, there are key elements for the success of this training in students: inspiring teachers (professionally trained), study programs aligned with the demands of the environment and with a strategic, innovative and transformative vision, learning environments (no longer just spaces) with the use of technology and experiential learning (including Artificial Intelligence). The link with the environment becomes more relevant, not only to respond to current and future demands, but also to become a relevant actor by sharing real problematic situations where students develop and strengthen their graduation skills by solving challenges [6].

Competency-based education could use different educational models, such as active learning, experiential learning, project-based learning, or challenge-based learning. The focus of this research is related to how the interaction with training partners of competency-based education impacts the desired development of students by linking them to real situations. These training partners can be public or private organizations, national or foreign, of any size or sector, with which the university decides to link to implement the academic challenges of its different engineering programs, promoting contact between its students, guided by their professors, with the reality and practice of their discipline.

In CBL, students work with teachers and stakeholder experts on real problems to develop deeper knowledge in study. The difference between the challenge and the project lies in the level of uncertainty of the experience, while in the project, the result may be known by the designers, in the challenge it triggers the generation of new knowledge, as well as the learning of tools and resources. . The challenge approach aims to engage students in a relevant and open-ended problem situation for which a real solution is required [7,8,9]. Here we analyze the case of a higher education institution with the competency-based educational model, through challenge-based learning, where its engineering programs are linked to the training partner from the second year of the degree to the fourth year. The objective of the research is to define the role of training partners in the development of engineering students' skills, including transversal skills or soft skills, as well as their disciplinary skills.

II. Methodology

The research methodology is mixed [10,11], and is made up of the following steps: a) Planning and delimitation of the research (period, academic programs, etc.) b) establishment of the instruments to be used, which are surveys the stakeholders (companies or organizations such as Educational Partners, as well as teachers and students), the role of training partners through interviews and the evaluation of students' competencies; and finally, c) the analysis of the data to identify the impact of the interaction on the training of engineering students.

A. Planning phase

For planning purposes, the August-December 2023 semester was defined as the semester to carry out the research, since it is the ninth semester where the CBL method is applied, and in June the first generation of students graduated under the. TEC21 educational (fully CBL in all subjects). The research team is made up of professors from the School of Engineering, from different disciplinary areas and with experience in educational innovation.

B. Qualitative and Quantitative Instruments

The instruments used were surveys and interviews. Formal surveys, which are administered to students, teachers and training partners, at the end of the course. This allows for greater certainty of the feedback received from a sample of students, teachers and educational partners. The interviews were conducted with teachers who were selected for their experience in developing challenges and working collaboratively with other colleagues to apply the challenge-based learning method. These interviews were in-depth, with a guide of questions to review the Trained Partner's impact on challenge-based learning, competency development, and role during the challenge.

In addition, an evaluation of disciplinary and transversal competencies is carried out. For the purposes of the research, the common disciplinary competencies in engineering (4, see Table 1) and the transversal competencies (7, see Table 1) will be taken into consideration, for students of engineering programs.

TABLE I. ENGINEERING COMPETENCIES

Disciplinary Competencies	***Transversal competencies***
Foundation of engineering systems and science	Self-awareness and management
Data analysis in engineering and science	Innovative entrepreneurship
Solving complex problems	Social intelligence
Commitment with sustainability	Ethics and citizenship
	Reasoning for complexity
	Communication
	Digital Transformation

Each transversal (soft) competence has sub-competences which are measured with monitoring and evidence. Below is a brief explanation of each competency for a better understanding:

Transversal competencies [12]

Self-awareness and management. Knowing themselves and managing their life plan.

Innovative entrepreneurship. Developing entrepreneurs who innovate and are socially engaged.

Social Intelligence. The ability to interact with other people through negotiation and collaborative work.

Ethics and citizenship. To develop behaviors of integrity, honesty, and sense of citizenship.

Reasoning for complexity. Integrates critical and systemic thinking and learning to learn.

Communication. Effective use of oral and written language.

Digital Transformation. Use of technology to make processes efficient.

Disciplinary Competencies [13]

Fundaments of engineering systems and science. Basic knowledge of the operation of engineering systems based on principles of natural sciences, mathematics, and computation.

Data analysis in engineering and science. Analyzes engineering systems data in the decision-making process, using mathematical tools and information technologies.

Solving complex problems. Solves complex problems by applying methodologies in both controlled and uncertain environments.

Commitment with sustainability. Applies sustainability standards in the solution of problems related to the operation of engineering systems.

Finally, the analysis is developed with qualitative and quantitative information from the instruments considering the different stakeholders, their perspectives, and the development of student competencies.

C. Characteristics of the participating sample

This study considers the total number of students in the engineering school programs evaluated in the period August-December 2023, to understand the role of the training partner in the development of transversal competencies. Even though the competency development and evaluation processes are continuous, they are evaluated at different times of the year, which is the reason for the difference in the number of students.

The students evaluated in the period from august- December 2023 according to the evaluation plan of the programs, are presented in the Tables II and III. It is interesting to note already some comparisons, such as the number of students who were evaluated with the competency of reasoning for complexity (63,000 students), which means that it is developed and evaluated in a greater number of courses within the curriculum of the engineering programs. That is, a student may be evaluated more than once on the same competency in different courses.

TABLE II. NUMBER OF STUDENTS ASSESSED BY TRANSVERSAL COMPETENCIES

Transversal competencies	***Number of students assessed***
Self-awareness and management	14,070
Innovative entrepreneurship	6,500
Social intelligence	2,460
Ethics and citizenship	7,050
Reasoning for complexity	63,800
Communication	24,000
Digital Transformation	34,500

Table III illustrates that the evaluation of the disciplinary competencies is evaluated in only one course of the curriculum, at a more advanced level.

TABLE III. NUMBER OF STUDENTS ASSESSED BY DISCIPLINARY COMPETENCIES

Disciplinary Competencies	***Number of students assessed***
Foundation of engineering systems and science	1,870
Data analysis in engineering and science	8,500
Solving complex problems	5,300
Commitment with sustainability	2,800

D. Case study description

The university's engineering school has 18 professional engineering programs, which are taught on different campuses throughout the country.

Each program consists of 8 semesters, made up of courses and blocks (educational units made up of modules taught by a team of teachers and a challenge linked to a training partner). The courses apply the problem-based learning method, while the blocks apply challenge-based learning.

As part of the academic guidelines of the School of Engineering, it was defined that the relationship with the Educational Partners begins with the blocks from the 2nd year until the end of their career in the 4th year.

Linking with educational partners is the responsibility of the professor or the academic department that manages the block. The process is the following:

1. Based on the predefined challenge, an educational partner interested in solving a similar problem is sought.
2. Discussions are held and the challenge is finalized jointly between teachers and the collaborating educational organization.

The work plan is defined with the role of the training partner.

All the above is prior to the first day of classes of the academic semester, in this case August-December 2023.

In the block(course), during school time, the team of teachers, the students teams and the training partner are in constant communication, each one in their main role:

- The teachers impart knowledge modules necessary for the development of the challenge, in addition they are facilitators and academic guides for the student teams.
- The students, in teams, analyze the challenge, obtain data, generate conclusions derived from this analysis and make proposals for solutions.
- The training partner shares information, guides the students' teams and sometimes, depending on the degree of progress of the block in the curriculum, provides feedback.

At the end, the teaching team carries out the evaluation of the students' competencies, according to the individual evidence presented. This evaluation is registered in the internal competency evaluation system, which integrates the evaluation of the competencies of all the students at the engineering school per period.

III. RESULTS

As part of the case study, the results of the application of the instruments to the three main groups of interest are considered: the interviews with the teachers who are in charge of the CBL course, the training partners with whom the challenge is developed, and the students, to whom the competencies are developed.

A. Qualitative Results: Interviews

As for the interviews with the professors regarding the role of the educational partner in applying the didactic challenge-based learning method, they indicate that:

- During the process of design, delivery and evaluation, there are different people representing the educational partner, who develop different roles: as project leaders (those who define the project), experts of the situation linked to the challenge (information providers and student guides), and those who conduct the evaluation of the outcome of the challenge.
- The degree of involvement varies depending on the level of advancement of the course in the curriculum: If it is a second-year course, the link with the educational partner is reduced, while a course as an integrative project in the last year, the educational partner has a constant presence during the period it is developed. This constant presence has several objectives: orientation, information sharing, validation, feedback, and evaluation (according to rubrics previously agreed upon with the professors).
- One of the most interesting impacts of the linkage with educational partners in the last year of the program is the commitment with the challenge and with their own discipline, seeing how in real time their proposals are applied in dashboards of use for companies in LATAM (in data analytics). The teamwork, the guidance of the facilitators of the organization, as well as the professors, generate these impactful results.

Some of the points to be careful of are that the students are challenge oriented (which is linked to the course and was defined together with the educational partner), they are not there to solve the problems that arise or everyday problems, as trainees of the organization.

B. Surveys Results.

Regarding the training partners who are linked to the courses of the different semesters of the curriculum through CBL, they receive, at the end of each course, a survey where they provide feedback on the experience of their training link with teachers and students. In the selected period, surveys were applied in the three short periods that make up the semester, and the average results are shown in Figure 1, where the satisfaction of the training partners is evident, both in the training experience and in the results obtained, in addition. of the continuity of their commitment to the institution, the program, the students, courses, and faculty.

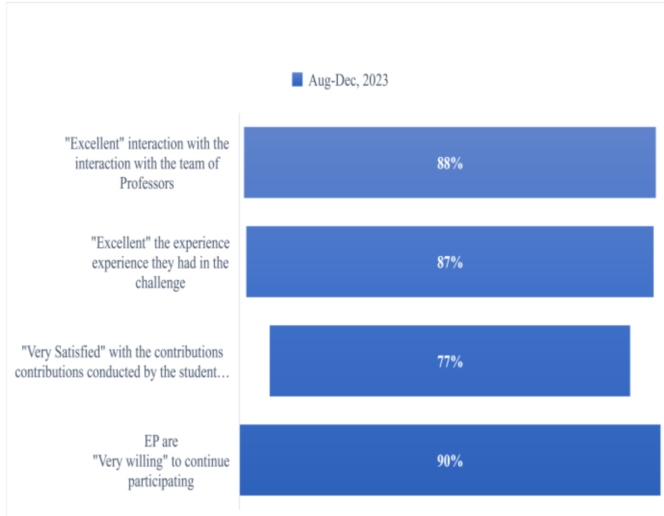

Fig. 1 Feedback from the educational partners with CBL

Additionally, there is qualitative feedback, where the educational partners of the programs comment that:

- "The students left no detail out, the research they conducted was very good."
- "We found the work done by the students very enriching, I think they have learned a lot about how construction information is managed in real projects, and they have also provided valuable information for the institution."
- "To the team of professors, they did a great job, and you can see their vocation and passion for what they do. To the students, for their motivation in taking on this challenge. Happy to collaborate with you."

Students also provide feedback on the linkage with the educational partners and the impact on their learning:

- "Very good the educational partner for being of international stature and giving us what we need for the challenge."
- "This is the first time I have worked with an educational partner who is so committed to our challenge, I am very grateful that we have been able to get these educational partners."
- "We appreciate the willingness and trust offered by the educational partner for the development of our challenge, as well as the feedback provided."
- "The challenge was quite promising and allowed us to apply a lot of knowledge."

C. Evaluation of competencies

In the process of evaluating the students' graduation competencies, there is evidence defined and designed by the professors, and linked to the challenge. This evaluation is conducted according to incipient, basic, solid and outstanding levels. In the evaluation of the transversal competencies presented in Table 1, Figure 1 shows the % of fulfillment of the competencies either in one of the basic, solid or outstanding levels. As can be seen, more than 90% of the students in the 18 engineering programs comply with them (see Fig. 2).

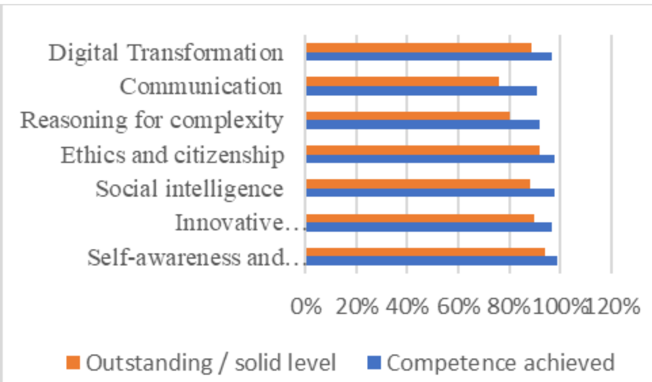

Fig. 2 Percentage achievement of transversal competencies with CBL

In the common engineering disciplinary competencies (see Table 1), the same levels as above are considered, and where it is shown that compliance is 95% or more in some of the three levels (basic, solid or outstanding) See Fig. 3. However, in contrast to the high percentage of students' development of the competency, there is an opportunity for improvement, as the program seeks to strengthen the development of this competency at a solid or outstanding level, not only at a basic level, as is observed in the Foundation of engineering systems and science competency.

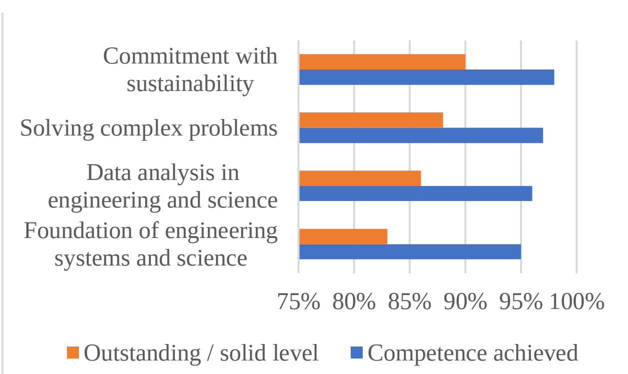

Fig. 3 Percentage achievement of disciplinary competencies with CBL

In this model where professor, students, didactic strategies and close linkage with the environment through stakeholders, allows the development of transversal and disciplinary competencies, in a desirable level of compliance as it is the solid or outstanding. This allows us to respond to the demands of the complex environment faced by our organizations, companies and society in general.

The impact of the training partner in the development of transversal competencies is observed through the evolution of the challenge and during the feedback sessions, where communication and critical thinking are present. It is important to clarify that the training partner does not evaluate competencies, but supports their development by providing real situations, with information and constant guidance according to the level of the challenge and the block in the curriculum plan.

CONCLUSIONS

1. The role of the training partner as an interested actor in the CBL, whether a company, organization, government, or civil entity, depending on the degree of advancement of the curriculum, distinguishing different functions, commitments and limitations, increases the complexity of the training experience

2. The perception of benefits is greater among students, teachers, and training partners, for the understanding of the discipline, and the development of the skills and values that are formed, translated into transversal disciplinary competencies and soft skills.

3. The development of one's own competencies, in the different stages of the study plan until reaching the advanced level, where the training partner takes part not only as a trainer of competencies but also as an evaluator of their development. It is important to highlight that the benefits are many, and so are the commitments, as well as the process for this to result in the desired impact: training young people with life skills with a high sense of social and professional responsibility, meeting the demands of the complex and changing environment that we face today as a society.

4. Teachers in charge of CBL experiences must be committed to the role of being co-researchers of students and creating an environment conducive to solving the challenge.

For future studies, it is planned to go deeper into the types of challenges developed with the final deliverables achieved by the students through the work teams, as well as observations and interviews with the teachers, to contemplate the challenges, they face when developing this type of didactic technique in the development of transversal and disciplinary competences.

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