Improving Student Retention and Soft Skills: Faculty Experiences on Transitioning to Active Learning Approaches on First-Year Engineering Programs at Universidad Panamericana

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IMPROVING STUDENT RETENTION AND SOFT SKILLS: FACULTY EXPERIENCES ON TRANSITIONING TO ACTIVE LEARNING APPROACHES ON FIRST-YEAR ENGINEERING PROGRAMS AT UNIVERSIDAD PANAMERICANA

**Previous results from this study were presented at IATED and INTED conferences

1. Motivation and problem background

This complete evidence-based practice paper describes the pedagogical redesign process of an introductory Physics course for first-year engineering students at Universidad Panamericana, and the experience of professors that applied problem and project-based learning methodologies.

Teaching and learning concepts and approaches in higher education are experiencing dramatic transformations due to contextual changes in recent years. Contemporary teaching models are student-centered, and based on active learning, technology, and social media integration. Engineering education research has grown exponentially, and even though there is vast evidence of how different teaching practices can improve learning, professors still face many barriers to include them in their practice. Adequate transfer of conceptual knowledge to problem-solving requires appropriate pedagogies that ensure student engagement in the learning process.

Quality of instruction and pre-college preparation are critical for student success in STEM courses, and therefore, in the decision of students to stay in these programs [1]. In Mexico, according to ANFEI (National Association of Colleges and Schools of Engineering), only 40% of engineering students graduate on time. First-year courses are easy for some students, but represent a big challenge for others, being the latter those who frequently do not succeed [2]. In addition, research has shown that student's prior mathematics and physics training, as well as their academic attitude, influence their decision to stay in STEM majors [3], [4].

Additionally, since 2010, Universidad Panamericana has deployed a series of strategies to help students strengthen their professional skills. These strategies include skills ABET proposed for engineering graduates, such as multidisciplinary teamwork, critical thinking, and effective communication. Nevertheless, there is still a significant gap between the skills that engineering graduates need to succeed in the workplace and those developed through the college experience.

To address the previous concerns, the Center for Innovation in Education (CIE) was invited to collaborate with the College of Engineering at this Mexican University to redesign an introductory physics course. The content of this course includes pre-college preparation which has been identified in the literature as a factor that contributes to the persistence of students in engineering programs. Problem and Project-based Learning (PBL) methodologies were chosen to teach the course, and strategies to develop students' soft skills were included. The course was taught in the fall of 2017.

In this paper, we describe the redesign process that CIE followed in collaboration with three engineering faculty members teaching the course. Also, we present the results of the qualitative study which sought to explore the experiences of the eight professors teaching the redesigned course.

2. Literature Review

2.1 Engineering teaching and learning

Engineering colleges and universities face a large number of students leaving their programs before graduation, despite years of research and efforts to increase retention rates. In the U.S. over the last 60 years, engineering graduation rates have been around 50% [4]; similarly, in Mexico, engineering graduation rates barely achieve 40%. A review of the literature conducted by Geisinger and Raman [4] identified a set of factors that contribute to the attrition of students. These factors include classroom and academic environment including teaching and advising, grades and conceptual understanding, self-efficacy and self-confidence determined by high school preparation in math and science among others. Engineering educators have argued that personal and socio-economic factors can contribute to the attrition of students; however, there is a proportion of engineering students that leave because of the educational system. Studies have shown that retention can be increased by addressing these factors [4].

Engineering education research has helped to advance our understanding of engineering student learning and teaching [5]. Several studies have shown that active learning methodologies engage students in their learning and are more effective than traditional lecturing [6]. Moreover, strategies such as project-based learning (PBL) can help not only with student academic learning; but they can also develop relevant soft skills among college students; PBL has shown to facilitate learning, to encourage student collaboration, and to help students apply new content to solve problems [7], [8]. Cabrera et al. [9] explain that teaching styles are more important in predicting student success than other factors such as pre-college preparation.

Inadequate teaching and advising is a commonly cited reason why students leave engineering. Studies also report a mismatch between the way engineering is taught and the way students learn; there are still institutional and individual barriers to change faculty teaching practices. At the institutional level, Singer and Smith discuss that strategies that have been successful in engineering education include a deliberate focus on teaching and learning, the importance of recognizing the culture of the institution, and the support to change teaching practices [5]. Similarly, since 2012, the discipline-based education research (DBER) report recommends that institutions need to support faculty to use evidence-based strategies in their classroom, and prepare them to value effective teaching as part of their career aspirations [5]. Furthermore, Eddy, Converse, and Wenderoth [8] discuss how these strategies developed to encourage active learning need to acknowledge the day-to-day life of faculty as well as potential barriers described in the literature, such as the limited effort to train faculty members on teaching methods. At the individual level, faculty may not recognize that their teaching strategies are not as effective as other strategies; professors can lack clarity of what active learning is, or how to engage students in active learning strategies, and finally, they doubt about the implementation of the teaching techniques [10], [11], [12]. Moreover, literature has proposed that soft skills are difficult to teach and evaluate [13], and most professors in engineering colleges are technical specialists who are not trained in formal teaching skills. The training of engineering professors requires to understand two different fields, first, the particular disciplinary area and second, the teaching and learning approach [14]. In addition, in some cases, faculty may not put the same effort into their teaching as they do into research because of institutional policies.

2.2 Soft skills and engineering

Engineering education professionals have recognized that graduates need to possess soft skills apart from their technical knowledge. A clear distinction has been established between "hard skills" and "soft skills". On the one hand, "hard skills" are associated with technical proficiency such as the ability to solve mathematical problems, design systems, or computer programming. On the other hand, “soft skills” refer to how people interrelate with each other and how they approach the general situation. These skills include oral and written communication, leadership, creativity, problem-solving, and teamwork, among others. It is important to mention that the term “hard” can be a synonym of difficult in the academic environment, resulting in less merit related to non-technical matters [15].

Many studies mention that soft skills are increasingly important for engineers in the workplace. Communication and interpersonal skills are identified in the literature as the most important soft skills in engineering. Moreover, demands coming from employers for graduates with different skills have led higher education institutions to include more practical experiences as a way to develop soft skills. Felder and Brent discussed that teaching and learning need to be changed in order to meet ABET and workplace requirements [16].

Researchers and professionals share how soft skills can be learned through the application of theory and by introducing them in technical subjects. Demands have led to the introduction of different activities in teaching methods, such as PBL, which can be introduced in the curricula to develop students’ soft skills so as to improve self-education, self-development and personal and professional competences [17]. Furthermore, Done and Willmot shared how creative teaching styles are required to engage students in non-technical matters, introducing the teaching of soft skills into the technical curricula [18].

Students and faculty perceive that soft skills are not sufficiently emphasized in the curricula. The fact that hard skills dictate the curricula can create a bias toward hard skills, and often put soft skills aside, even to a point of disdain. Furthermore, engineering programs need to provide soft skills learning opportunities for students and help faculty understand the importance of their role in developing these skills among students besides fostering deep technical understandings [19].

3. Introductory Physics course redesign through project-based learning

In this section, we describe the course redesign process and the initial results regarding the assessment of students’ understanding of theoretical concepts according to the Force Concept Inventory, comparing these initial results with similar Latin American experiences. Afterward, we describe the methodology and findings of the qualitative study seeking to understand the experiences of professors teaching the PBL course.

3.1 Description of the redesign process.

In 2016 the Engineering College began a curriculum redesign process. Soft skills development among students was one of the main elements introduced to the new plan. For the introductory Physics course in the first semester of all undergraduate engineering programs, the five key soft skills selected were teamwork, systemic thinking, creativity, analytic thinking, and oral communication.

In addition, the course content centers on general topics such as static and dynamic principles, Newton's laws, energy, and work. These topics are studied deeper on further courses, but the primary objective is to make the student capable of:

- recognizing different physics phenomena and its variables,
- explaining, clearly and concretely, the physical model that drives the solution, and will obtain results that he can understand, explain and present.

Thus, we selected project-based learning as the most appropriate learning methodology to enhance such soft skills in students while fostering the academic knowledge of the course. To begin the course redesign process, the Center for Innovation in Education developed an e-learning course to introduce department heads and professors to the PBL methodology. The course contents centered on answering questions such as: What is project-based learning? How can I apply project-based learning in my class? How have other universities and faculty used this methodology? Throughout the course, professors' views on ideas that arose for their classes, constraints, and restrictions perceived to apply the methodology as well as perceived benefits of this methodology for their class were explored through forums.

After the introductory online course, the physics course redesign process began with three participating professors (two of them were department heads and the other one was the college dean). They participated in three sessions with the Center for Innovation in Education to deepen their understanding on the soft skills selected for the course and define which specific indicators and dominance levels were desired for students to reach during this introductory course. Then, the course program was reviewed, to analyze its connection with the soft skills selected. Finally, the guiding question for the course project was established.

These three professors continued to work in over ten sessions to redesign the course with PBL. Since it was an introductory course, the content scope was extensive, so a Goldberg Machine was selected as the guiding project for the course. This project will allow students to apply and connect the broad scope of knowledge acquired throughout the course. A Goldberg Machine is a machine that performs a specific task in an ordinarily complicated sequence that follows specific steps linked together in a way that each step triggers the next one until the task is completed.

The goal for students was to design, build, and test an 8-step Goldberg Machine, applying and documenting the principles learned in the physics course. The machine could be built of any non-dangerous material available to the students and would be evaluated at the end of the course, by three fundamental aspects. The first was blueprints and work on the Dossier. Students would be assessed following the steps of the blueprints previously designed, so the machine had to be assembled in its optimal conditions. Then, a Dossier would be evaluated. This Dossier contains every calculation and scheme made for the machine to be built. These blueprints and calculations were done in the class sessions, while students learned the course topics through collaborative and active learning activities guided by professors. The second aspect to be evaluated was the machine's functionality; the machine should function correctly according to the Dossier calculations and schemes, following the previously planned steps without human interactions. Finally, the third aspect to be evaluated was the disassembly of the machine; students should be able to dismantle the machine without excessive force and in a way that shows the students knowledge of the machine components.

Finally, after the course redesign was completed, the eight professors to teach the class were invited to an informative session, to explain them the course objectives, the soft skills selected for the course, the learning methodology to be applied, and the course plan in general.

After the pilot semester, we used the Force Concept Inventory (FCI), initially developed by Hestenes, Wells, and Swackhamer (1992) and translated to Spanish by Macia-Barber and Hernández [20], to evaluate students. This inventory assesses the understanding of the basic concepts of Newtonian mechanics and has proved to be useful in evaluating how different teaching methodologies impact learning. We compared our results with those of Latin American universities, presented in the Artamonova, Mosquera-Mosquera and Mosquera Artamonov paper [21]. Such study describes how students with entry levels below 27.7% of correct answers, considered novice, achieved post-test results between 26.5% and 59.7%. The lower level of post-test scores was obtained in groups with traditional teaching methodologies (mainly lectures), while higher results were found with active learning methodologies such as 4MAT, situated learning, and IDEA, among others.

Two groups participating in our university redesigned course pilot, took the FCI pre-test at the beginning of the semester, and the post-test at the end [22]. Pre-test results reveal that students started at a novice level, with an average of 26% of correct answers. In post-test results, students achieved 44.55% of correct answers on average. Artamonova et. al suggest that this improvement can be attributed to the active learning methodology used to redesign the course [21]. This approach helped students obtain higher grades that contribute to improving retention among first-year students.

In a previous study, we explored the experience of students taking the pilot class [23]. For the present study, we explore the experiences of the professors teaching the course. We describe the methodology and findings in the following section.

3.2 Methodology and findings

3.2.1 Methodology

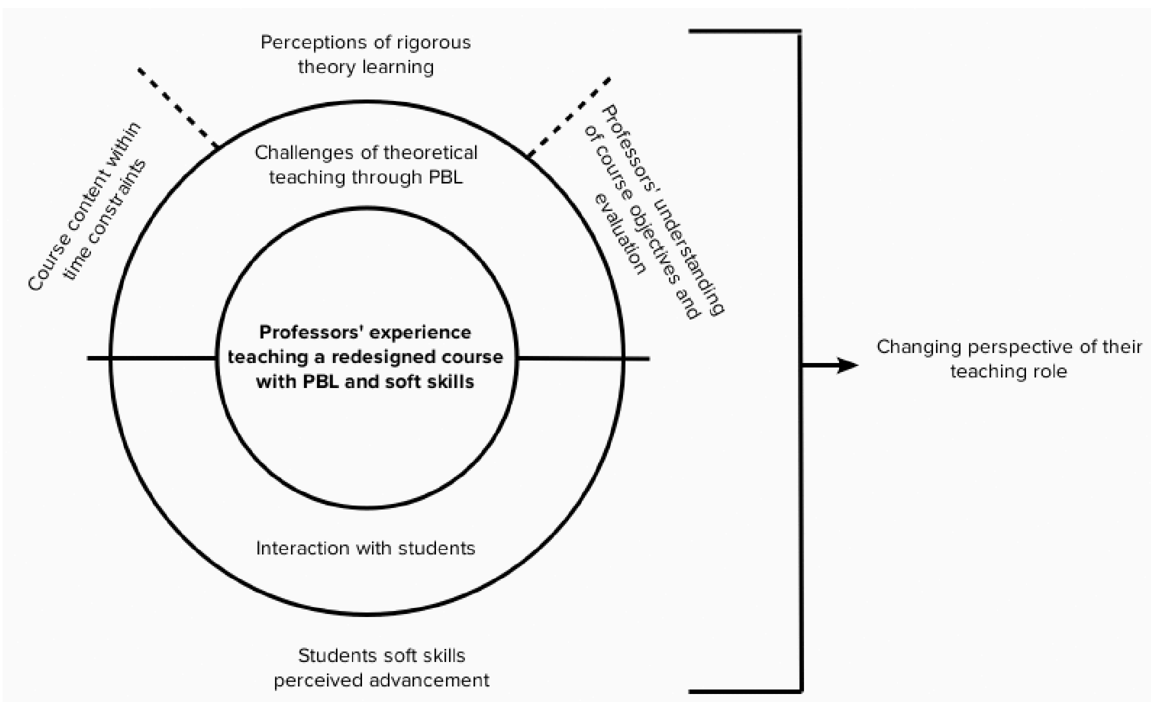
The qualitative study presented was designed to explore the experiences of faculty members that taught the redesigned introductory Physics course presented above. A focus group was conducted with eight professors that taught all sections of the class, seeking to understand their experiences on teaching through student-centered and active learning approaches. During the focus group interviews, facilitators described the purpose of the study and assured confidentiality. An interview guide was used, with a set of questions about professors' experiences with projects, students, learning activities and evaluation methods. The semi-structured interview guide allowed to prioritize the questions and help with the conversation flow. The interviews were audio recorded and transcribed for analysis. Professors shared insights about their teaching experiences, their perceived abilities that helped them throughout the course; and finally, the difficulties and concerns they found while teaching the class. One of the researchers was the primary data gathering instrument; this researcher has taught in the College of Engineering for more than 15 years.

Qualitative data analysis is primarily inductive and comparative. We chose a basic qualitative research approach described by Merriam and Tisdell [24] as a simple way to understand a phenomenon and the perspectives of the people involved. We used a constant comparative method of analysis which consists of identifying units of information, compare them to determine similarities and recurring patterns, and then group them into categories. Finally, we identified relationships between these categories [25]. Resulting categories include teaching experiences and interaction with students.

We present the results in two languages, English and Spanish because we intend to inform two audiences. First, the College of Engineering community in Mexico, and the English speaking academic community [26].

3.2.2 Findings

To describe the findings of the study, we divide this section into two parts; first, we present the challenges professors face to teach theoretical content through Problem and Project-based learning(PBL), an active learning methodology. In the second part, we describe how professors recognize the development of soft skills among their students, and how the active learning methodology changes the way professors interact with their students and conceptualize their teaching role. The following figure illustrates the findings.



Challenges of theoretical teaching through PBL

<u>Course content within time constraints</u>

The first finding that emerges from this study was the experiences of professors teaching the redesigned class. Even though all participants had experience in teaching Physics in the College of Engineering, they felt uncertain about the new methodology. Some of the most critical concerns shared by the professors were related to time constraints; learning activities designed for active learning and soft skills development take more class time than traditional approaches. Thus, being able to cover the complete class syllabus was a constant concern for faculty. Professor 2 explains, for instance,

> [One of my main concerns was] to cover the material of the class due to the number of projects [students were required to do].
>
> [*Una de mi mayores preocupaciones] fue tratar de cubrir el material con tantos proyectos. [FP2]*

Similarly, professor 8 describes how for her, it was important to define what are the most important topics of the course,

> I would like to know the minimum [content scope to be covered] …I would like to know what content is really important and what is going to be covered in the following Statics course.
>
> *A mí me gustaría mucho saber como el mínimo…me gustaría saber esto sí es importante que lo vean en física y lo demás lo verán [en otros cursos] en estática. [FM8]*

Some professors were not able to review all the topics in class, so they decided to choose or prioritize some topics over others . For example, professor 6 describes,

> In fact, for me was vectors…, I even covered the topic of tridimensional vectors, …I told them [the students]: "if you learn this topic, it is going to be very useful when you take the mechanics course."
>
> *De hecho, para mí fue vectores, …llegué a vectores tridimensionales… y les dije si aprenden esto les va a servir mucho cuando lleguen a mecánica [siguiente clase]. [MP6]*

Likewise, professor 8 shares that she reviewed all the material; however, she only covered the last part superficially,

> "I covered all the course content, but I only mentioned the last part."
>
> *["Yo cubrí todo, pero lo de energía fue platicado"]. [FM8]*

Since the class was an introductory Physics course, professors shared how in subsequent courses students will cover deep content, professor 8 described,

> I would be a good idea to review other courses included in the program and decide which topics are more important to cover deeply and which ones just as a review because they are going to take more courses.
>
> *Sería bueno ir revisando las materias que llevan en el plan y decir en física qué temas son importantes a profundizar y cuál es un mero repaso porque después van a llevar más materias. [FP8]*

Moreover, professor 6 shares with his students how materials will be covered in subsequent courses so frequently, that students ended-up joking with him,

… As I started a topic, I explained to the students that this was a basic course that would be useful for other courses. Finally, they understood that the course introduces fundamental concepts to start up.

... conforme les iba explicando que estudiamos un curso básico que les va a servir para las otras materias. Al fin y al cabo, les quedaba claro que era una base relativamente fundamental para arrancar. [MP6]

[Students] even joked, and imitated me saying, “Ok, I will explain it to you in Statics, Dynamics and Materials.”

Y me iban imitando, diciéndome Ok .. ya les contaré en estática, ya les contaré en dinámica y en materiales.[MP6]

Besides covering the topics in class, professors believe there were too many activities (projects) to complete during the semester. Professors expressed their concerns about the need to select among the projects. Professor 2 explains, “Each student had 10 to 12 evaluations per period”. [*Cada uno tenía entre 10 y 12 evaluaciones por periodo]. [FP2]*.

Furthermore, participants described that the selection of projects needs to be analyzed and more importantly adjusted according to the curricula. Professor 3 shares how, for her, it will be useful to order the projects by relevance and allow professors to choose among them to reinforce the content.

It would even help us decide which activities could be reinforced and which ones should be removed or simplified… to decide which activities have to be prioritized in a group.

[Ayudaría incluso a tomar decisiones sobre qué actividades podemos reforzar y cuáles quitar o simplificar… a decidir qué actividades son prioritarias en un grupo]. [FP3]

Perception of rigorous theory learning

In addition to time constraints to cover the curriculum and the need to prepare and evaluate many different projects, professors explained how the exam grade was not as important as it was in other courses they have taught. At the College of Engineering, most of the basic courses are evaluated through two partial exams and one final. In this course, the exam grade was averaged with the different projects; professors shared their concern because, in their opinion, students were not paying enough attention to the exams. Furthermore, since professors were used to evaluating through tests, they shared how uncertain they were about students’ learning.

Moreover, professors state that in previous semesters, they were used to receive many students for review sessions before the test; however since the test grade was averaged with those of the projects, fewer students were attending the review sessions. Professor 5 states,

The idea was that in the first test being Physics, the students would be worried. Therefore, they would ask for tutoring and revision sessions. However, this time, when they took the test and realized that it did not have too much weight in the final grade, they [students] did not worry for the second test.

La idea era que el primer parcial, siendo física… [los estudiantes por los talleres y tal. … Cuando ven que hacen su examen y no les va tan bien, ven la evaluación y que no

> *afecta tanto [en la calificación final] … ya no se preocuparon por el segundo parcial. [MP5]*

Similarly, Professor 6 continues, “And then before the second tests, we only had 9 or 10 students instead of 25 [in review sessions]”. *Entonces ya antes del segundo parcial y antes del final pues había 9 o 10 en lugar de 25 [en asesorías].”*

In contrast, professors share how some students were very concerned with learning the content

> .. Some [girl students] were very diligent, and they always asked me “professor, we need tutoring, like 2 or 3 hours to do exercises before the test.”
>
> *Había unas niñas bien estudiosas y siempre me pedían “profesor queremos asesoría de dos o tres horas para hacer ejercicios previos al examen. [MP3]*

Professor 6 describes how he proposed theoretical problems as challenges to his students, and students who were able to solve three of those challenges did not need to take the test. “The exercises were more theoretical, because students were very good*”, [Y eran ejercicios más del estilo escolarizado porque eran los alumnos de los que daban]. [MP6]*

In the same way, Professor 4 shares he gave the students a theoretical guide to help them better grasp the material.

<u>Professors’ understandings of course objectives and evaluation</u>

The objective of the course was not clear to all participants. For some professors, it was evident that the academic curriculum need to be covered while giving space to develop soft skills, Professor 1 explains,

> No, because in the end the activities are designed to work with both objectives, soft skills, and Physics. We cannot lean towards one side; we need to find the middle ground.
>
> *No porque al final las actividades son para que funcionen en los dos objetivos, tanto soft skills como los que tengan conocimientos de física, no podemos irnos solo a un lado, debemos encontrar el punto de medio. [FP1]*

However, professors also discussed how they were uncertain about the course objective. It was clear to the interviewers that some professors stated two different objectives for the course. On the one hand, the academic curriculum, and on the other hand the development of soft skills. Professor 4 describes,

> … what you are telling me is knowledge, what Carlos is saying is knowledge, and I am uncertain about the objective of this course planning. It is supposed to be to develop soft skills, I think it is a challenge.
>
> *Entonces, lo que tú me estás diciendo es conocimiento, lo que está diciendo Carlos ahorita es conocimiento, y yo otra vez me quedo con la incertidumbre del objetivo de la planeación de este curso era para desarrollar habilidades yo creo que es ahí el reto, ¿no? [MP4]*

Some professors were not able to fully integrate both objectives, Professor 5 shares, for instance,

> Well, I did not set it up that way… I believe that from the beginning you need to understand how much weight to assign to the learning of soft skills and how much to assign to Physics knowledge.

Bueno yo no lo plantee así … yo creo que desde el principio el esquema debe clarificar cuánto pesa que aprendan habilidades y cuánto pesa que aprendan física.

Professors 6 explains the importance of the learning experience,

> The content [curricula] is one thing, and the experience is another thing. … This experience will be more valuable in their professional life than the content of the course.
>
> *El concepto es otra cosa y el alcance de la experiencia es otra …. Esta experiencia va a pesar más en la vida profesional que el [contenido] de la materia. [MP6]*

In addition to the objective of the course, professors were concerned about student evaluation. They explained how they were used to evaluate academic content but not soft skills, Professor 5 describes,

> No, because evaluating academic content is clear to us, it is what we do on a daily basis, but the other ones [soft skills], it is what we are learning …
>
> *No, porque las de conocimiento las tenemos claro porque es nuestro quehacer, pero las otras es donde estamos aprendiendo….*Moreover, Professor 4 expresses doubts about the evaluation of soft skills,
>
> No, I cannot guarantee, as you directly ask. In contrast, I will change the question: Develop soft skill? Do they [students] really develop those skills?
>
> *No tengo como garantizar, así como dices la pregunta directa, primero la pregunta yo la cambiaría. ¿Desarrollar habilidades? ¿De verdad las desarrollaron?*

Similarly, professors' main concerns focus on how to properly evaluate soft skills, for example teamwork, and academic content. Even though they had a rubric to evaluate the course, professors found it very complex as Professor 5 describes below,

> Well, I do not know if you can measure or develop soft skills, but the rubric… It was complex; I do not know how to explain the rubric to students.
>
> *Bueno mira no sé si de medirlas o de desarrollarlas… Y estaba el asunto de la rúbrica,,, era un poco compleja. No sé cómo se la dieron a entender a los alumnos. [MP5*]

Professor 4 ads, "Above all, teamwork, there was a particular evaluation for teamwork." *"Y sobre todo el trabajo en equipo, porque había una evaluación en particular de trabajo en equipo. [MP4]*

In this previous section, we described the challenges that professors experienced while teaching theoretical contents through PBL. Professors reflect on their previous practice and compare the results with the new learning model. They cited uncertainty about how to develop students' soft skills while fostering rigorous learning of Physics. In the next session, we present how the new methodology allowed professors to interact differently with students, and how they perceived the development of soft skills among their students.

Interaction with students

The second category of findings centers on professors' interaction with students in two dimensions. The first dimension relates to the perceived advancements on students' soft skills development: teamwork, effective oral communication, and systemic thinking. The second dimension describes how faculty experienced a change in their interaction with students.

Professors became more self-aware of the teaching and learning processes. They also gained a deeper understanding of how to give useful feedback on students' work and oral and written presentations of their projects. Most professors state that teamwork improved throughout the PBL course. Professor 2 shares:

> Well, what I see here is that teamwork was one of the skills that students perceived they did develop.
>
> *Bueno, lo que yo veo aquí es que una de las habilidades, en general, que [los estudiantes] pudieron percibir que sí se pudo trabajar fue la del trabajo en equipo. [FP2]*

Furthermore, professor 3 describes, "They did improve teamwork, from the middle of the semester to the end." *Sí mejoraron el trabajo en equipo, de la mitad del semestre al final. [FP3]*

Professors state that students learned some keys for successful teamwork. For example, for having good relationships inside small group and know how to deal with conflict and crisis. Faculty also perceived some problems inside the teams, among students. They explained how they handled these issues through feedback and communication. Professor 7 explains it in the following quote:

> So, we do not choose [our] kids, we do not choose [our] parents. It is the same in a team. So, that team was all chaos. I had to dedicate myself [to them] and to explain myself and such; and I think that, at the end of the day, they understood [the idea].
>
> *Entonces, no escogemos a los hijos, no escogemos a los papás. Es igual en un equipo. Entonces, ese equipo fue todo un caos. Tuve que dedicarme y explicarme y tal, y yo creo que al final del día sí les queda algo. [MP7]*

Professors managed to identify leaders for each team, thus promoting positive leadership. Besides, they believe how this practice might be an effective strategy for positive team building. It is clear that faculty became more conscious of the importance of sensibly assembling each team for the PBL methodology. Professor 7 describes her experience,

> We planned it that way because it always happens. What we did was [get the students to choose their teams] for the Goldberg Machine [...] then you realize who the leaders are, and then, for the final project, [...] you assign them as leaders for the following phases of the project.
>
> *Lo teníamos previsto de esa manera porque siempre pasa. Lo que habíamos hecho es [que los alumnos eligieran sus equipos] para la máquina de Goldberg [….] entonces tú te das cuenta quiénes son los líderes, y después, para el proyecto final, [….] a esos que detectaste [como líderes] los pones como núcleos para los siguientes equipos; los pones a decidir con quienes van a acabar.* [FP7]

This appeared as an effective strategy for professors, as Professor 7 continues,

> I had [each team] core divided and I can say that the six machines were beautiful [...] It did help to make the students leaders.
>
> *Yo tenía los núcleos [de cada equipo] divididos y yo sí puedo decir que las seis máquinas estaban preciosas [...] Sí les sirvió hacer líderes a los alumnos.* [FP7]

Moreover, pre-college preparation was cited by professors as one of the most influential factors for student success. They shared how they experienced difficulties while teaching the introductory Physics course to students with weaker pre-college experience, similarly to other courses they have taught. For some students, the topics were easy to learn, and in consequence their projects were better presented, and for others, projects were very challenging and frequently they did not succeed. Professor 3 explains,

> This phenomenon has always happened... there are two [sides], the good ones [students] they get bored and the other [students] that tell you "they have done it, they have explained me, but I do not get it.
>
> *Ese fenómeno siempre pasa ... hay los dos, los muy buenos que se aburren y los que te dicen, ya lo hicieron, ya me explicaron y no entiendo."*

However, one professor asked students with a strong Physics background to lead the project teams with good results:

> … You separate them [good students] and [tell them] you are going to help me set the teams, and we start negotiating … [I told them] we are one team, we all need to learn and working in teams helps a lot. And it, actually, worked very well.
>
> ... *los separas y así "me ayudan a armar los equipos y así comenzamos a negociar quién se queda con quién, ... todos somos un equipo, tenemos que aprender, ayuda muchísimo trabajar en equipo, ayuden a sus compañeros", y me funcionó muy bien [FP6].*

Being able to observe students while they worked in teams for their projects, allowed professors to give feedback on their performance. Professor 6 shares,

> I think it is very enriching because, in general, students never get that kind of feedback. It even gives you the opportunity to identify students who have trouble with teamwork and say to them: "Hey, I think you need to pay more attention to this", from the first semester of their degree.
>
> *Creo que es muy enriquecedor porque, en general, nunca tienen ese tipo de retroalimentación. Te da la oportunidad incluso para detectar chicos que tienen problemas para realizar trabajo en equipo y decirles: "Oye, creo que debes de poner más atención en esto", desde el primer semestre de su carrera.*

In the same vein, faculty perceives effective oral communication as a soft skill developed by students. Professors consider communication as a consequence of teamwork because students depend on each other for their grades, so they need to interact adequately with each other. Professor 6 states, for instance:

> Yes, because verbal communication means also being able to talk with your team; it is defending your ideas and perhaps explaining the ideas you have. Then, when they work in teams in front of you [...], you also realize who is speaking and who is quiet.
>
> *Sí, porque la comunicación verbal es también poder hablar con tu equipo; es defender tus ideas y quizás explicar las ideas que tienes. Entonces, cuando los pones a trabajar en equipo delante de ti [...], también te das cuenta de quién es el que habla y quién es el que calla. [MP6]*

Professors believe that working in teams requires students to be open to talk and to listen. It also helps students defend their ideas and explain them in a clear manner. Faculty developed a deeper consciousness of effective oral communication and how to help their students develop it. Some professors even feel confident giving feedback to their students. Professor 4 describes,

> Then I told the student: "I think it is OK, your personality must be respected, but you do need to communicate your ideas more and be clearer." [. . .] But it was hard for her to talk, she had to get out of her comfort zone. I think that enriched her a lot.
>
> *Entonces, en la retroalimentación yo le dije: "Me parece muy bien, hay que respetar tu personalidad, pero sí necesitas comunicar más tus ideas y ser más clara." [...] Pero le costaba hablar, había que salir de su zona de confort. Yo creo que eso enriquece mucho. [MP4]*

Some professors share that the PBL methodology helped students to develop and practice systemic thinking, principally by solving the Goldberg Machine.

> Remember that systemic thinking is [about] cause and effect. And that is why we set up the Golberg's Machine project. [. . .] They [the students] are designing for something to happen, and if they see the system globally, they are already contributing to systemic thinking.
>
> *Recuerda que el pensamiento sistémico es de causa y efecto. Y por eso lo pusimos con el proyecto de la máquina de Goldberg. [...] Ellos están diseñando para que ocurra algo, y si ven al sistema de forma global, ya están contribuyendo al pensamiento sistémico.* [FP7]

Participants explain how they are more aware of the PBL teaching process and how this methodology improve the interaction with students. This self-awareness has also made them reflect on their teaching role and on the soft skills they want to develop in students.

> What always helps is to have a clear idea about what you want to develop. If you already know what you want to develop with your graduates, then you are already conscious, something has to be done. That is always very good. Something the engineering student lacks.
>
> *Lo que siempre ayuda es tener una idea clara y expresar qué quieres desarrollar. Si ya sabes qué quieres desarrollar con tus graduados, entonces ya estás consciente, hay que hacer algo. Siempre eso es muy bueno. Algo que al ingeniero le falta. [FP2]*

Thus, professors notice how students need to have a shift in their mentality as engineering students and acquire the soft skills that the industry is requiring. For example, Professor 2 describes,

> [Students] are fearful, they say: "what is this? Am I to be obliged?" I mean, it's not the engineer profile I want to have. I want one who says "I am an engineer, of course I know how to solve equations [...], I could do anything else for you, just [say what], bring it up." [...] And that change of mentality is what I would like to have in all my students. [...] I would like us to have that kind of [engineer] profile [...].
>
> *Traen un miedo, de verdad, de: "¿qué es esto? ¿Y me van a obligar?" O sea, no es el perfil del ingeniero que quiero sacar. Yo quiero echar uno que diga: "soy un mecatrónico, por supuesto sé resolver ecuaciones [...], te podría hacer cualquier otra*

cosa, échamelo, venga". [...] Y ese cambio de mentalidad es el que a mí me gustaría tener en todos mis alumnos. [...] Entonces me gustaría que pudiéramos tener ese tipo de perfil [...].

In addition, this overall experience led professors to reflect on how their teaching role changes when they apply student-centered learning approaches. Despite their consciousness about the importance of this role change, they shared a need for deeper training to be able to transition to these new models. Professor 3 explains, for instance,

> [...] I think it [soft skills and PBL integration in class] would not work if we just tell new professors, "Here, you have to apply this". We do have to prepare professors in aspects such as how to evaluate skills behaviors, despite the scheme you decided to use for your course, how to detect these behaviors, such as teamwork, or the most effective processes for feedback.
>
> *[...] creo que sólo no funcionaría [integrar soft skills y PBL] si sólo se las damos, "ten, tienes que aplicarlas". Sí, hay que preparar al profesor desde cosas como de cómo puedes revisar ciertos comportamientos, independientemente del esquema que utilices en tu clase, cómo puedes detectar estos comportamientos de otra manera, como trabajo en equipo, o los procesos más efectivos de retroalimentación para que sí funcione.*

4. Conclusions

The study describes the experience of eight professors teaching the re-designed Introductory Physics course at the College of Engineering at Universidad Panamericana. The course was designed with the Center for Innovation in Education to develop soft skills while teaching the Physics concepts. The qualitative perspective gives us a deep understanding of the experiences of professors. Main results include the challenges they face while teaching the content and guiding the students through the projects, including time constraints, not feeling confident about how to include the developing of soft skills and how to evaluate the results. In addition, professors share how they recognized the developing of soft skills among their students, such as teamwork, leadership, oral communications, and systemic thinking. Despite challenges (such as time constraint, different learning methodologies, and evaluation criteria), professors in this study describe how this methodology improved their teaching and allowed them to acquire a deeper understanding of their students. Moreover, professors share that they need a deeper training to be able to apply PBL and soft skills effectively in their courses, and should be involved in the redesign process to enhance the assimilation of the new model.

Findings provide insights to transition into a student-centered model. Higher education institutions need to include active learning methodologies and partner with different centers to reshape the curricula and provide experiences to improve the learning of students and to develop soft skills among its graduates. Universities need to foster opportunities like this course, where soft skills development were specified in the course learning objectives to help faculty transition to student-centered models.

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