Sustainable and accessible container house: developing soft skills in an interdisciplinary way

Casa contêiner sustentável e acessível: desenvolvimento de habilidades interpessoais de forma interdisciplinar

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Andromeda Goretti de Menezes Campos
PhD in Industrial and Systems Engineering
Institution: Instituto Federal do Espírito Santo - Campus Cariacica
Address: Cariacica - ES, Brasil
E-mail: andromeda@ifes.edu.br

Danieli Soares de Oliveira
PhD in Environmental Engineering
Institution: Instituto Federal do Espírito Santo - Campus Cariacica
Address: Cariacica - ES, Brasil
E-mail: danieli@ifes.edu.br

ABSTRACT

Currently, sustainability is being widely evaluated as a way to ensure the development of society, meeting the needs of the current generation, without compromising the ability to meet the needs of future generations. Another very evident aspect is accessibility, which aims to implement measures to remove barriers, to promote broad and unrestricted access, with safety and autonomy, for people with disabilities or reduced mobility. Therefore, educational actions related to these aspects are valid, in the sense of making society aware of the importance of taking care of oneself, others and the environment that surrounds them. With the objective of contributing to the professional training of the Production Engineer, as well as to the construction of a more correct and fair society, in the themes of sustainability and accessibility, this paper aims to describe and discuss the results of the application of the Project Based Learning (PBL) approach in a Production Engineering course. For this, it was necessary to: carry out a bibliographic review of the content; collect data from projects developed by students; analyze the collected data; and present the results. The theme was the development of sustainable and affordable container house projects. In this sense, the teams worked to highlight the potential of this form of construction as a viable alternative to the conventional method, according to the specificity of each client, indicating its potential and limitations in the face of obtaining sustainable and accessible spaces. As a result, it was possible to verify the students' knowledge about the themes; the development of technical and transversal skills; in addition to consolidating PBL as the methodology adopted in the discipline. Finally, the project reached the proposed aim, thus contributing to the construction of an environmentally correct, economically viable and socially just society.

Keywords: engineering education, project based learning, sustainability, accessibility.
RESUMO
Atualmente, a sustentabilidade está sendo amplamente avaliada como uma forma de garantir o desenvolvimento da sociedade, atendendo às necessidades da geração atual, sem comprometer a capacidade de atender às necessidades das gerações futuras. Outro aspecto bastante evidente é a acessibilidade, que visa implementar medidas para eliminar barreiras, promover o acesso amplo e irrestrito, com segurança e autonomia, para pessoas com deficiência ou mobilidade reduzida. Portanto, ações educativas relacionadas a esses aspectos são válidas, no sentido de conscientizar a sociedade sobre a importância de cuidar de si mesmo, dos outros e do ambiente que os cerca. Com o objetivo de contribuir para a formação profissional do Engenheiro de Produção, bem como para a construção de uma sociedade mais correta e justa, nas temáticas de sustentabilidade e acessibilidade, este artigo tem como objetivo descrever e discutir os resultados da aplicação da abordagem de Aprendizagem Baseada em Projetos (PBL) em um curso de Engenharia de Produção. Para isso, foi necessário: realizar uma revisão bibliográfica do conteúdo; coletar dados dos projetos desenvolvidos pelos alunos; analisar os dados coletados; e apresentar os resultados. O tema foi o desenvolvimento de projetos de casas contêineres sustentáveis e acessíveis. Nesse sentido, as equipes trabalharam para destacar o potencial dessa forma de construção como uma alternativa viável ao método convencional, de acordo com a especificidade de cada cliente, indicando suas potencialidades e limitações diante da obtenção de espaços sustentáveis e acessíveis. Como resultado, foi possível verificar o conhecimento dos alunos sobre os temas; o desenvolvimento de habilidades técnicas e transversais; além de consolidar o PBL como a metodologia adotada na disciplina. Por fim, o projeto atingiu o objetivo proposto, contribuindo assim para a construção de uma sociedade ambientalmente correta, economicamente viável e socialmente justa.

Palavras-chave: educação em engenharia, aprendizagem baseada em projetos, sustentabilidade, acessibilidade.

1 INTRODUCTION
The increase in competition, technological changes and greater demand from consumers have demanded greater agility, productivity and high quality from organizations. Therefore, project development is considered one of the key elements for business competitiveness and it has gained the recognition of organizations as an alternative for competitive differentiation (Teixeira et al., 2012; Radujković & Sjekavica, 2017). Thus, the projects development has become increasingly important in organizations and allows the company to modify, improve and strengthen its position in relation to the competition. In order that the aims of a project to be achieved, it is needed to be managed properly, that the management techniques and tools are used considering the specificities of each project and even that those responsible for management, the project managers and their teams have domain this knowledge and know how to apply it (CAMPOS, 2020).
Society is in constant social and technological evolution, so that its relationship with the community and the environment changes continuously. New durable and consumer goods are improved, as well as the ways of communication, interaction and occupation of spaces, aiming at greater comfort, productivity and economy. Strands such as sustainability are currently being widely evaluated, to guarantee the development of society, meeting the needs of the current generation, without compromising the ability to meet the needs of future generations. Another aspect that is highly evaluated at the present time is accessibility: in several countries, including Brazil, accessibility is a right, guaranteed by law, which is intended to implement measures to remove physical, architectural, communication and attitudinal barriers, to promote broad and unrestricted access, with safety and autonomy, for people with disabilities or reduced mobility. In this way, educational actions related to these aspects are extremely important, to educate society about the importance of taking care of oneself, others and the environment that surrounds them.

However, traditionally, the format of the teaching-learning process is marked by the central position of the teacher, considering him/her as the holder of all knowledge, and placing students as passive actors in the process. It is necessary to make a transition between teaching and learning based on the idea of transmitting knowledge, to one based on the development of competences, which allows the future professional to obtain the ability to mobilize learning resources in specific, academic and/or professional contexts. For this, the professor of the discipline of Planning and Project Control, of the 7th period of the Production Engineering course, of the Federal Institute of Espírito Santo (Ifes), Campus Cariacica, uses the Project Based Learning (PBL) to conduct it.

In this sense, this article aims to discuss and analyze the results of using PBL as an educational methodology for the Project Control Planning discipline, as well as the insertion of transversal knowledge such as sustainability and accessibility, for students of the 7th period of the course of Production Engineering, from Ifes, Campus Cariacica.

With this study it is expected to consolidate the knowledge of students of this discipline with regard to concepts, techniques and tools in the area of agile project management (hard skills), as well as in the acquisition of transversal knowledge inherent to project management (soft skills). Added to this is the contribution to the construction of an increasingly environmentally correct, economically viable and socially just society. In addition, discussing
and introducing the teaching of sustainability and accessibility in a massive way cooperates so that its concepts are understood, experienced and produce effective and perennial behavioral changes.

2 CONCEPTUAL BACKGROUND

This item describes a brief literature review, necessary for the development of the discipline's planning, to contemplate the largest possible number of competences established by the Brazilian Association of Production Engineering (ABEPRO), as well as by the Accreditation Board for Engineering and Technology (ABET) and the European Accreditation Board for Engineering Education (EUR-ACE), as we are inserted in a globalization context.

2.1 ENGINEERING EDUCATION

The ABET and the European EUR-ACE for the accreditation of Engineering Education, bring new skills to the professional in this area. These skills are linked to the challenges that the current world imposes for this professional, which must be developed during the teaching and learning process. They are: ability to work in multidisciplinary teams; ability to identify and solve applied science problems; understanding of professional and ethical responsibility; effective communication skills; broad education needed to understand the impact of solutions in a global and social context; recognition of the need and ability to engage in lifelong learning; knowledge of contemporary issues; and ability to use modern scientific and technical techniques, skills and tools necessary for professional practice.

In Brazil, the Brazilian Association of Engineering Education (ABENGE) brings the following skills to meet the profile of the Engineer: identify, formulate and design solutions to complex problems (problem solving); design and conduct experimentation, analyze and interpret data, and obtain results (search); conceive, design and analyze systems, products, components or processes (project); simulate and analyze different scenarios with a focus on decision making (management); communicate effectively (communication); working and leading multidisciplinary teams (teamwork); ethically interpret and apply legislation and normative acts within the scope of the exercise of the profession (legislation and ethics); recognize the need for teaching/learning throughout the working life (permanent updating); and specific skills, in accordance with the Engineering course in terms of the chosen modality and required regional
characteristics (modality) (ABENGE, 2018). It is important to note that the competencies defined by ABENGE are in line with the competencies defined by ABET and EUR-ACE.

Engineering education is the basis for the development of society. Without technological innovations, there will be no production of new goods, no economic growth and no human development. Innovations are part of market mechanisms to establish new markets. Markets demand a rapid development of innovations and, therefore, of technological and scientific knowledge (Kolmos, A., Dahms, M. and Du, X., 2012).

For Kolmos, Dahms and Du (2012), innovation creates many challenges for engineering education; therefore, the authors bring some statements that lead engineering education to a process of changes: 1. Knowledge can become outdated in a few years, which creates challenges for engineering education around the world; 2. Innovation is no longer based on individual knowledge, but on collaborative knowledge; 3. The collaborative construction of knowledge is increasingly complex. On the one hand, globalization requires new ways of sharing work, involving intercultural understanding of international collaboration. On the other hand, complexity involves interdisciplinary knowledge constructions; and 4. There is a big challenge in making this rapid technological development much more sustainable on issues such as the environment and social responsibility.

2.2 PROJECT-BASED LEARNING

Project-Based Learning (PBL) is one of the teaching and learning methodologies that have been adopted by engineering schools, and which has contributed to aid universities respond to the challenge of changing their practices. PBL aims to promote learning through student participation in finding solutions to complex problems (Graaff & Kolmos, 2003; Powell & Weenk, 2003; Lima et al., 2011).

In addition, a project brings together both theoretical and practical aspects. In the case of interdisciplinary projects, they aid to make the teaching-learning process more attractive, encouraging students to explore new ideas and discover new ways of applying the concepts acquired in the classroom, developing the ability to formulate hypotheses, investigating solutions, drawing conclusions and establishing relationships between the several assimilated contents. However, project themes must be relevant, motivating, and challenging. Lourenço and Paiva (2010) state that a motivated student adopts an active attitude in the learning process,
engaging in challenging tasks, expending effort, performing tasks enthusiastically, and feeling accomplished with their performance. Finally, PBL (Project-Based Learning) is a methodology that stimulates the learning of programmatic contents through the involvement of students in real and challenging situations. The authors Costa, Pinheiro, and Pilatti (2012) consider that project-based learning contributes to the development of interdisciplinarity, problem-solving skills, students' investigative spirit, and allows for a connection between school content and everyday life.

Characteristics of the PBL: it must be based on a problem; get a concrete result; to be interdisciplinary; to be inserted in a real context; enable open and unrestricted solutions; provide teamwork; have a long duration; and be an initiative carried out only once, in a limited time, to deliver a certain result, whether it is a consumer good, service or result.

3 STUDY SUBJECT

The project addressed in this research was carried out in the year 2021, with students from the Project Planning and Control course of the 7th semester of the undergraduate program in Production Engineering at the Federal Institute of Espírito Santo, Cariacica Campus.

The Project Planning and Control course, the subject of this research, blends both traditional and active approaches, specifically Project-Based Learning (PBL). In this course, students work in teams with the objective of developing the planning of a project, as well as executing, controlling it, and delivering a final product, whether it's a physical item, a service, or an outcome.

For the choice of the theme, it was considered that the use of containers in the construction industry is still not widely employed in the country, but satisfactory results have been observed with their use, especially when involving sustainability issues. The technique seeks the reuse of containers, which are large metal boxes, commonly used for transporting goods via various means such as railways, maritime, road, among others. By repurposing them for the construction industry, it's expected to provide them a new purpose, reducing the amount of resources required in the building production process.

Despite the course having used this working method since 2017, this study describes the experience that took place in the semester of 2021/1, within a pandemic context, in which the
course was entirely conducted remotely, demanding a much greater level of self-control and discipline from the students.

4 METHODOLOGY

In this section, the adopted methodological choices for the study's development are described, considering the justifications that motivated the conduct of this research, as well as the contributions derived from it based on the obtained results. The topic is presented in a manner that characterizes the research, from the perspective of the utilized methodological approach, the necessary data collection and analysis techniques, and the stages of the work's development, which will be undertaken to fulfill the objective of this proposal.

4.1 RESEARCH METHODOLOGY

Regarding the type, the research described here is considered an action research. According to Tripp (2005), action research is focused on problem-solving within organizations, involving the participation of the individuals concerned and fostering an awareness of what is being done and why it is being done. This type of research was chosen due to the frequent interaction between the researchers and the students, as well as the possibilities for improving the application of the learning methodology during its development, based on the continuous feedback provided by the students. The authors already possessed initial knowledge about PBL, but they were unsure of how the methodology would perform in this specific class, considering the execution of the course in an online format due to remote teaching, as well as the incorporation of cross-cutting content related to accessibility and sustainability. To conduct the course in this context, the authors relied on their prior knowledge of projects developed, both in the Project Planning and Control course and in other subjects within the curriculum of the undergraduate program, as well as their understanding of active learning, project-based learning, sustainability, and accessibility.

The research described here has a descriptive nature, as the researchers have previous knowledge of the issue. It is a qualitative-quantitative approach. Quantitative in that the results will be measured through numerical data, and qualitative due to the need to handle information directly from the perceptions of direct participants during the data collection process, to gain deeper insights into the subject under study.
The main data collection techniques used were Observation, Questionnaire, and Document Analysis. In this research, the decision was made to conduct observation without a structured form, but rather in a spontaneous and natural manner. Therefore, recording information in the field diary was considered crucial. It captured behaviors, reactions, and attitudes of various team participants, aimed at aiding individual assessment of the students. Observation allows for the capture of phenomena that cannot be registered through questions or quantitative documents but must be observed in the actual situation in which they occur (Deslandes, 2007).

As per Gil (2010), a questionnaire can be defined as an investigation technique composed of a more or less extensive set of written questions presented to individuals, with the aim of gaining insight into opinions, beliefs, feelings, interests, expectations, lived experiences, etc. Thus, for empirically oriented questions, the questionnaire serves as a technique to collect information about the organization's reality. The same author presents the following advantages of the questionnaire over other data collection techniques: it allows reaching a large number of people, even if they are dispersed over a vast geographic area; it entails lower personnel costs since the questionnaire does not require researcher training; it guarantees the anonymity of responses; it allows individuals to respond at their convenience; it does not expose researchers to the influence of interviewees' opinions and personal aspects. The questionnaire used in this investigation aims to understand the students' expectations and perceptions of the project. Furthermore, through the questionnaire's application, it's possible to analyze the results of using PBL as an educational methodology in the Project Planning and Control course, as well as the significance and outcomes of incorporating cross-cutting knowledge such as sustainability and accessibility.

Document Analysis was necessary because in project management, many documents are generated from project conception to closure, involving communication among participants and lessons learned, which serve as reference for new projects. Stake (1995) attributes to document analysis a complementary role to other sources of evidence and emphasizes the importance of such information as a substitute for situations that couldn't be directly observed.

In action research, one plans, implements, describes, and evaluates a change for the improvement of their practice, learning more throughout the process, both about the practice itself and the research, as shown in Figure 1.
4.2 WORK METHODOLOGY

For the development of the Project Planning and Control course, Project-Based Learning (PBL) was employed. The project's theme was "Sustainable and Accessible Container House," led by professors Andromeda Goretti de Menezes Campos and Danieli Soares de Oliveira, who held the following roles, respectively:

- Supervisor; responsible for Project Management content and tools, Accessibility; in charge of team guidance and mentoring.
- Supervisor; responsible for Sustainability content; Technical Drawing and Structures; team guidance; also serves as the client.

The project aimed to develop the floor plan of an accessible and sustainable container house, conducted in teams, to build knowledge about various Project Management agile techniques and tools to be studied in the Project Planning and Control course, as well as to draw upon other subjects studied in the program, to find the best solution for the project while meeting stakeholder requirements.

To achieve the overarching objective, students had to review specialized literature on concepts related to the project; develop the Project Scope; create the Project Plan (knowledge areas of Project Management – PMBoK); implement the proposal; control the Project; deliver the container house floor plan; and present results through reports, partial deliveries, and a seminar.

In Stage 1 of the course, Contextualization, the professor introduced the concepts of Projects, Project Management, and their application in Production Engineering. During this stage, successful and unsuccessful project examples were discussed, along with their reasons. Additionally, the professor highlighted the potential, scope, and global impact over the past
decades. This was achieved through interactive lectures, activities, digital educational materials, and audiovisual resources. In this stage, the professor introduced the course's methodology and provided a brief review of PBL and how the course would be conducted. The goal was to contextualize students about the course, the content to be studied, their role in the program, and motivate them for project development.

Moving to Stage 2, Preparation, teams were formed, and subtopics were chosen. Each team could consist of a maximum of 4 students, selected freely from the class, considering factors like affinity, partnership, commitment, among others. Students were divided into 5 teams, with 4 students each, totaling 20 students. This choice was made by them using the Moodle Learning Management System (LMS) platform. Each team was numbered, and videos presenting the project's subtopics, also numbered, were shown to the respective teams. In this stage, each team was assigned a distinct challenge, incorporating accessibility and sustainability concepts. The subtopics were the construction of accessible and sustainable container houses for: Team 1: Mother with an autistic child; Team 2: Elderly couple; Team 3: Couple with adopted children; Team 4: Individual with low vision; Team 5: Wheelchair user. The objective of this stage was to provide motivation through a challenge. In this link, you can find videos containing reports on the subtopics. An explanation of the competencies required for a Production Engineering professional was also given, aligning them with the competencies of a project manager, as well as the cross-cutting competencies that this teaching method could help students acquire. Students took the Belbin Test, identifying behavioral profiles – Leaders, Builders, and Creators – to determine each team's leader.

With the essential information in hand for project initiation, Stage 3 began – Research. Here, students conducted a literature review on subjects related to the project theme, such as sustainability in construction, the use of containers in building, accessibility, inclusion, among others, tailored to each team's specificities. It was necessary for students to gain knowledge and understanding of sustainability and accessibility features in a structure, as well as container characteristics, their specifications, and their relationship with sustainability and accessibility, along with comprehension of the container house construction process and its feasibility. The aim of this stage was a deeper understanding of the subject.

Stage 4, Development, commenced by introducing the knowledge areas of a project, detailing each phase, while focusing on Agile Project Management tools, whether for planning
or controlling the project. Theoretical-practical online classes, interactive exercises, collaborative environments – all led the teams to produce project components aligned with the Project Management knowledge area presented by the professor. Content relevant to each specific goal of the work was introduced, with moderation by the participating professors. Often, students had to seek support from other faculty members, which was their responsibility. Thus, professors acted as facilitators of learning, guiding students to solutions rather than directly providing answers, encouraging independent knowledge acquisition. Both professors assumed the client role, answering questionnaires and interviews conducted by the teams. Twice a week, students held virtual meetings to progress their projects – one monitored by a professor and one without supervision.

Stage 5, Evaluation, included project assessments by professors; partial project presentations; individual tasks; final project presentation and report. The latter involved an online seminar with evaluators (professors), diary entries, and peer evaluation. Furthermore, a final evaluation of the project, from the students’ perspective, was conducted through an online Google Forms survey. The final project report consisted of Theoretical Framework; Project Charter; Project Plan, encompassing Project Management knowledge areas; Intermediate products from management tools; Description of technical competencies gained in other subjects, used to find the best solution; Description of cross-cutting competencies for an Engineering professional acquired/utilized; Description of difficulties encountered during the process; and the final product, the container house floor plan, developed using applications chosen by the teams. Importantly, all tools used were free of charge.

5 RESULTS AND DISCUSSION

The data for the accomplishment of this research were collected from the reports of the partial deliveries of the project, the final report of the project and the evaluations of the project of the discipline by the students. From the data collected, it was possible to observe the gains obtained with the application of PBL as a methodology of the discipline.

To evaluate the progress of the work process in the development of the project, a questionnaire divided into two parts was presented to the students. Questions I to VI are closed considering a rating scale. And the second part, questions 1, 2 and 3 of item VII are open, where the student was expected to freely express his/her opinion on the exposed subjects.
Students used a score from 1 to 5 for each statement, in questions I to VI, where: 1 – I totally disagree; 2 – I partially disagree; 3 – I neither agree nor disagree; 4 – I partially agree; and 5 – I totally agree.

Figure 2 to Figure 9 show the most relevant results of the project evaluation performed by the students.

Regarding the relevance of the project theme to understand/know a little more about the profession, 50% of the students rated it 4 (I partially agree), another 40% rated it 5 (I totally agree) and only 10% rated it 3 (I neither agree nor disagree), as shown in Figure 2.

The project theme should be relevant to the course, concerning a deeper understanding and knowledge of the related profession. This directly impacts students' motivation towards project development.

![Figure 2 - Relevance of project theme](image)

Source: authors (2023).

Regarding the challenge provided by the theme, 40% reported they were motivated and challenged by the theme, 45% partially agreed about having been challenged and motivated, and only 15% neither agree nor disagree with this statement, as shown in Figure 3.

Only 5% of the students who responded that the theme is relevant disagreed that this fact makes the project motivating. The project achieved a fundamental objective, which is being challenging. This is justified by the chosen theme, which, being motivating, leads the student to adopt an active attitude in the learning process, taking on challenging tasks, expending effort, performing tasks with enthusiasm, and feeling accomplished with their performance.
Regarding the Learning and Skills developed, when asked if, with the work on the project, the student acquired and developed project management skills (research, decision, organization, problem solving, time management), 37% strongly agreed, 47% partially agreed and the remaining 16% neither agreed nor disagreed with the statement. This result was what can be seen in Figure 4.

The majority states that they developed these skills to some degree. This happens both because they were exposed to experimentation (the project provided the practice) and because they dedicated themselves, driven by motivation and challenges.

Within this same item, students were asked about the question: “The development of the project allowed me to better understand several contents related to with my course”. We had an expressive result here, as 60% fully agreed and 40% partially agreed. The result is presented in Figure 5.
The relationship of the theme with the studied course plays a fundamental role in the teaching-learning process, as the project leads students to understand and relate the subject being studied to other contents covered in the course and real-life situations, resulting in a more comprehensive knowledge.

Figure 5 - Perception of the relationship between the course contents.

Participation in the project also contributed to develop students’ autonomy. Of the 20 students, 60% totally agree, 20% partially agree and 20% neither agree nor disagree, as shown in Figure 6.

The development of autonomy is also an expected competence in project work since students shift from a passive position to an active and participative attitude in their own learning process. This and other soft skills were noticed both by the students and the teachers who accompanied them. A significant number of students experienced a behavioral change throughout the course development, transitioning from a passive position to a more autonomous behavior.
Among other aspects, 50% of the students considered that working on the project provided the acquisition and development of project management skills, which are not technical, such as the ability to investigate, decide, organize, solve problems and manage time; another 35% considered that this occurred partially; and 15% stated that they neither agree nor disagree with this statement. This result can be seen in Figure 7.

During the project activities, 55% of the students considered that their speaking, writing and interpersonal skills had improved; 40% considered that this happened partially and only 5% do not agree or disagree with this statement, as shown in Figure 8.
With regard to teamwork, specifically in the statement: “I prefer to work in a group than individually”, after this experience, the diversity of responses was higher, as can be seen in Figure 9.
Regarding the questions about the use of Project-Based Learning (PBL) as teaching-learning methodology for the Project Planning and Control discipline, 92.5% of the students fully or partially agree that: it contributes to the reduction of academic failure and course/discipline dropout; the development of projects has a positive impact on the relationship established with the teachers and the course; Moodle was an adequate tool for communication with teachers and for delivery of documents; and also that the role of advisors was important and indispensable in supporting teamwork.

The following reports are on the difficulties encountered by students and their teams in the development of the project, using the PBL methodology:

Team 1: “Understanding the reality and needs of a person with low vision.”; Team 3: “The biggest difficulty of the project was to be able to relate the requirements with the sustainability part, which is still a challenge in the civil construction.”; Team 4: “The work presented several challenges for us to reach its final delivery, among them the difficulty in the availability of time since all the members of the group are in internship activity, keeping the planned delivery dates throughout the project, and some other obstacles also caused by the COVID-19 pandemic. However, overall it proved to be a challenging experience, and one that can add to each of the members in a personal and special way”.

Next, reports about the positive points found by the students are described, with regard to the development of the project, using PBL as a methodology.
Student 1: “This project was essential this semester, mainly because it forced us to do practical work. I believe this is a better method of learning than just sitting in a chair and studying concepts. The fact that we applied the support tools was essential for us to have a more in-depth knowledge about the project planning and control tools. In addition, teamwork requires a lot of discipline and organization from each one, to be able to reconcile the tiring routine of internship and college with several tasks to be carried out”.

Student 2: “In my view, the skills that I developed the most throughout the process of making this project were the organization towards the project, through the tools we use for this skill (Trello; PM Canvas; WBS), and the issue of time management, since in our group, we are all interns and out of each one's commitments. The times we were all together, they were of maximum performance through the optimization of time. All of this, of course, associated with the teamwork that had a unique fluidity in the case of our group. Therefore, I believe it was a very important experience for our personal and professional growth, as we will have challenges like this in the job market in the future”.

Student 3: “The main skills I developed in this project were: organization, communication, teamwork and time management. The WBS, Canvas and Trello tools helped in the organization; communication and teamwork were developed due to the fact that the work was in a group, so all the members needed to keep in frequent contact; Time management was necessary since the team members do not have many schedules in common to carry out the work, so an agile time management was necessary to perform the tasks in a brief and assertive way”.

Student 4: “I believe that the skills most developed in this project were teamwork and organization. The issue of organizing the steps of the process, using tools such as WBS, PM Canvas and Trello helped the division of tasks and the development of the project in a way that was more effective according to the skill of each one of the group”.

Student 5: “I believe that the skills I developed over the time I studied the subject were time management and greater knowledge of the Trello management tool. It is worth mentioning that teamwork and understanding the time of each one were essential for the progress of the project, since all the members are interns. I would like to emphasize that, as I am working in the projects area, the knowledge acquired is being very useful and of great value to me”.

Student 6: “... another point, which I personally thought was very cool, brought to the subject, was the evidence for the cases of people with special needs, bringing evidence to the
cause and showing the importance of bringing thought to the special needs of these people in project development”.

Student 7: “It was very interesting, it brought a lot of knowledge in relation to accessibility, sustainability and especially in relation to project management, in learning the methods and tools used”.

Based on the above reports and the graphs in Figure 7/Figure 8, it is concluded that some results were achieved as intended, such as access to and understanding of the themes of accessibility and sustainability, which proved challenging for the students due to a few reasons: 1 - lack of interaction with people with disabilities, leading them to overlook these individuals and their difficulties in daily life; 2 - lack of awareness about sustainability, causing them to overlook the impact of their actions on maintaining the world for future generations.

Furthermore, the team reports and the accounts of some individual students show that the technical competencies and soft skills related to Project Management and PBL were achieved. The chosen working methodology, as well as the selection of the project theme and the inclusion of cross-cutting knowledge topics like sustainability and accessibility, brought significant progress in building knowledge for the students who participated in the course.

6 CONCLUSION

To develop their projects, student teams integrated theory and practice, drawing from methodologies, techniques, and tools studied in project management, along with a range of interdisciplinary knowledge, as addressed in this work: accessibility; sustainability; computer-aided design; environmental data analysis related to environmental science; and economic and financial assessment of engineering projects. Each team planned their project, leveraging prior knowledge acquired from previous courses, as well as new knowledge gained during project development, and employing computational technologies to generate their deliverables.

To contribute to society concerning sustainability and accessibility themes, the project in this course proposed the development of a sustainable and accessible container house. Through this project, it was possible to highlight the potential of this construction approach as a viable alternative to conventional housing methods, indicating its strengths and limitations in achieving sustainable and accessible spaces. Additionally, discussing and integrating the teaching of sustainability and accessibility on a larger scale could facilitate better comprehension and practical engagement with these concepts, leading to effective and enduring behavioral changes.
This research fulfilled the aim of discussing and analyzing the results of using PBL as an educational methodology for the Project Control Planning discipline, as well as the insertion of transversal knowledge such as sustainability and accessibility, for students of the 7th period of the course of Production Engineering at Ifes, Campus Cariacica. In addition, it was possible to consolidate project-based learning as the methodology of this discipline.

It was also possible to observe that the project met all the characteristics of the PBL methodology, since it was based on a problem; it achieved a concrete result; it was interdisciplinary; inserted within a real context; enabled open and non-restricted solutions; provided teamwork; had a long duration (5 months); and it was a one-time initiative, in a limited time, to provide a certain result, which in this case was a product.

It’s also understood that some students are meticulous observers, others prefer to attentively listen to what is said in the classroom, while others comprehend better when their knowledge is explored in practice. Each of them has different ways and strategies to solve problems, draw conclusions, assimilate content, and, in short, to learn. There are different ways of learning, and each individual employs a particular method of interacting, accepting, and processing stimuli and information. According to Silva (2006, p. 45), "Learning styles are related to the particular way of acquiring knowledge, skills, or attitudes through experience or years of study." Thus, we conclude that, although the methodology is well-established for this course, it cannot be considered the only way to work. It is necessary to explore the specificities, as people are different and learn in different ways, each already coming with a baggage of skills, competencies, and prior knowledge. It is essential to address other ways of conducting the course and evaluating the achieved results.

The pandemic context brought restrictions for students. The limitations of this research were: a) the use of technological resources necessary to carry out the tasks necessary for the development of the project at a distance and b) the fact that the students did not have access to the resources and physical space of Ifes. For some students, these were barriers that made it impossible for them to attend online classes, participate in team meetings, and even use project tools. Therefore, the final product of the project of this discipline was the design of the container house, limiting the result to a non-physical product.

With the return to face-to-face classes, the discipline will continue to work in a hybrid way. For the next edition of the discipline, it is intended to propose projects that bring sustainable
and accessible solutions to the community surrounding the Ifes, Campus Cariacica. Thus, it is expected that students develop with greater determination the search for knowledge construction and consequently find the best solutions for their projects.

Finally, this research is expected to encourage other teachers to use active methodologies, in an interdisciplinary way, and bringing concepts such as sustainability, accessibility, among others, to plant the seeds and promote engineers with global awareness, expanding their possibilities of problem solving and critical analysis.

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