

## Project-based learning: A scope review to support the teaching process in higher education



<https://doi.org/10.56238/ptoketheeducati-040>

### Cleunisse Aparecida Rauen de Luca Canto

Dra., SENAI/SC University Center - Campus Florianópolis – Brazil.

ORCID: <https://orcid.org/0000-0003-0679-8247>

E-mail: [cleo@sc.senai.br](mailto:cleo@sc.senai.br)

### Maristela Schleicher Silveira

Dra., SENAI/SC University Center - Campus Chapecó - Brazil.

ORCID: <https://orcid.org/0000-0002-0468-2411>

E-mail: [maristela.silveira@edu.sc.senai.br](mailto:maristela.silveira@edu.sc.senai.br)

### Valério Junior Piana

Specialist, SENAI/SC University Center - Campus Florianópolis - Brazil.

ORCID: <https://orcid.org/0000-0003-2579-2318>

E-mail: [valeriojuniorpiana@gmail.com](mailto:valeriojuniorpiana@gmail.com)

### Creciana Maria Endres

Dra., SENAI/SC University Center - Campus Blumenau - Brazil.

ORCID: <https://orcid.org/0000-0002-5662-2197>

E-mail: [creciana.endres@edu.sc.senai.br](mailto:creciana.endres@edu.sc.senai.br)

### ABSTRACT

Motivating and preparing students for the changes that the world of work imposes is challenging and requires a renewal in the teaching and learning process. In order for education to fulfill its social and formative role, educational approaches should provide students with experience in real problems. In this sense, Project-Based Learning (PBL) is a suitable proposal for the didactic-pedagogical process of universities. The objective of this study is to analyze scientific publications in recent years on the application of PBL in higher education. For this purpose, a descriptive exploratory research was carried out, based on a scoping review. 355 works were identified in the literature, which after applying eligibility criteria resulted in 52 articles (14.6%), and after analyzing the complete article, 14 (27%) remained and served as a support to substantiate the present work. The analysis allowed us to observe that PBL provides students with a direct relationship with real challenges in the industry, finding solutions and treatments for identified problems, which allows the development of competencies based on applied knowledge.

**Keywords:** Methodology, Learning, Projects, Teaching method.

## 1 INTRODUCTION

The application of new teaching methods, or the improvement of existing ones, has become an impetuous requirement in the various spheres that make up the educational sector. It can be said that the volatility of the job market is a direct response to the challenges that the world has been facing. According to Lynch et al. (2021), this is an increasing prerogative for educating, especially, students in the fields of science and engineering, in order to perpetuate the advanced development of scientific and technological knowledge.

The new knowledge space implies a change in traditional university education, establishing a new model for teaching. This new model changes the roles of the teacher and the student, focusing on the facilitator teacher and the active learner. The main objective is the acquisition of competences,



where the student acquires knowledge and skills linked to their future professional performance, meaning that the profile of the new academic is oriented towards acquiring knowledge for professional practice (MORALES; GARCIA, 2016, p. 472).

According to Posada (2004), competency-based education involves integrating disciplines, knowledge, skills, practices, and values necessary for the formation of good professionals. In the face of this new scenario, the methodology of Project-Based Learning (PBL) is an effective tool for acquiring the knowledge and competencies that the digital transformation society is demanding. PBL considers that learning occurs through the effort made by students to develop a project (GONZÁLEZ-CARRASCO, 2016).

Project-based learning, as a methodology focused on student protagonism and investigation, is a teaching strategy that helps students plan, implement, and evaluate their own projects (MORALES; GARCÍA, 2016). According to Cook (2006, p. 3), PBL aims to "[...] move away from approaches that typically see the roles of teachers as information transmitters," since it "[...] brings a more student-centered view, where they are actively involved in creating their own learning environment" (NTOMBELA, 2015, p. 32).

It is important to emphasize that a project is a complex task, based on questions or problems arising from a challenge, which involves the student in the conception, problem-solving, decision-making, and search for information that helps in the solution, giving students the condition to work relatively autonomously but relying on the alignments made in small groups (GONZÁLEZ-CARRASCO, 2016).

In line with PBL, the use of the TheoPrax Method, a teaching method of German origin developed in 1993, for example, allows for the integration of teaching and learning to favor motivation and promote professional maturity of students even in the school phase. The method is based on the development of competencies supported by knowledge, skills, and attitudes that contribute to encouraging an entrepreneurial spirit and improving the employability of students in the industry (KRAUSE et al., 2016).

By working on projects, students put their technical and scientific skills to the test through multidisciplinary, where they create a direct interface with real demands during the various stages, deal with project requirements, manage deliveries, and present results, which makes them think systematically for successful project completion. Furthermore, the use of PBL in the context of higher education proves to be a challenging strategy, where students develop deeper levels of understanding and acquire new skills that will help them cope with the challenges of the working world (GUTGARTS, 2020; ZAMORA-POLO, 2020; JIANG et al., 2020; PORTUGUEZ CASTRO, GÓMEZ ZERMEÑO, 2020; MORALES, GÀRCIA, 2016).



As an active methodology, the focus on project development in higher education instigates a more specific study, which allows identifying which strategies and approaches are used and how they are observed in the literature, as pointed out in this scoping review.

## 2 MATERIALS AND METHODS

This study was conducted through a scoping review, following the PRISMA-ScR<sup>1</sup> reporting guideline, without following a specific research protocol. The references obtained in the search were managed using Thomson Reuters Endnote X8 software (Clarivate Analytics, Philadelphia, PA, USA).

The research question that will be answered is: "What are the strategies used to maintain teaching and learning activities through project-based learning?" Regarding the selection criteria, studies that presented any type of educational strategy, method, or technique that used a project-based learning approach from any country were included. Studies that did not meet the eligibility criteria, as well as those that only theoretically reported data or aimed to obtain the perception of PBL practice, were excluded. Commentaries, editorials, conference abstracts, reports, systematic reviews, and other articles with personal information were not considered. Likewise, studies unrelated to teaching and learning were excluded (APPENDIX A).

The search strategy<sup>2</sup> was developed and executed by the reviewers and adapted to the Scopus® (Elsevier) database. The searches were performed on July 25, 2022. The results were filtered by access type (open access), publication stage (final), and document type, where only articles were selected, provided they were written in English, Spanish, or Portuguese and in the 'open access' format.

The article selection was performed in two stages by two reviewers (CC and MS), using the Rayyan® platform. In stage one, both reviewers independently read titles, abstracts, and methods and applied eligibility criteria. In stage two, the same two reviewers read the full text. In both phases, all retrieved information was cross-checked by a third reviewer (VP). The final selection was based on the full text.

Regarding data collection and mapping, the results obtained from the analysis of both reviewers were gathered in a spreadsheet. Subsequently, a table was generated with the collected data, which included the characteristics of the studies (author, year, and location), the title, the objective, and the main strategic measures for the teaching and learning process. The synthesis of the results was performed narratively in the discussion, and the studies were grouped in descending order based on the year, as shown in Table 1.

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<sup>1</sup> Available at: <http://annals.org/article.aspx?doi=10.7326/M18-0850>, accessed in May/2022.

<sup>2</sup> ( TITLE-ABS-KEY ( project AND based AND learning ) AND TITLE-ABS-KEY ( "higher education" ) AND TITLE-ABS-KEY ( universit\* ) ) AND ( LIMIT-TO ( PUBSTAGE , "final" ) ) AND ( LIMIT-TO ( DOCTYPE , "ar" ) ) AND ( LIMIT-TO ( LANGUAGE , "English" ) OR LIMIT-TO ( LANGUAGE , "Spanish" ) OR LIMIT-TO ( LANGUAGE , "Portuguese" ) ) AND ( LIMIT-TO ( OA , "all" ) ).



### 3 RESULTS

The Scopus® database returned 1,779 references. After removing duplicate articles using reference management software, 1,689 remained. After applying filters for language, publication type, and open access format, 355 (20%) articles remained for analysis. These were screened by title and later by abstract using the Rayyan® Platform. Of these, 52 (14.6%) studies were selected, but only 14 (27%) remained in the sample because they met the inclusion criteria. A summary of their descriptive characteristics is available in Table 1.

Table 1 - Characteristics of the included studies

AUTHOR, YEAR, PLACE, TITLE	OBJECTIVES	STRATEGY
(ARAÚJO et al., 2021) United States of America Innovation in the teaching of introductory physics in higher education: the Applied Physics 50 course at Harvard University	Present a teaching methodology based on teams and projects, created in the context of Applied Physics 50 (AP50), a course at Harvard University.	Project-Based Learning (PBL)
(MARTÍN-GARIN et al., 2021) Spain Pedagogical approaches for sustainable development in building in higher education	To use the conception, development, and implementation of innovative and alternative educational proposals to current teaching models, with a clear focus on sustainability-related concerns.	Project-Based Learning (PBL)
(HASLAM; MADSEN; NIELSEN, 2021) Denmark Problem-based learning during the covid-19 pandemic: Can project groups save the day?	Discuss how digital PBL, through project groups, had a positive impact on student motivation during the COVID-19 lockdown.	Project-Based Learning (PBL)
(FERNANDES; DINIS-CARVALHO; FERREIRA-OLIVEIRA, 2021) Portugal Improving the performance of student teams in project-based learning with scrum	To analyze the effectiveness of Scrum for project and team management in PBL teams in higher education.	Project-Based Learning (PBL) linked to Scrum Methodology
(HERGET, 2020) Portugal Project-based learning in the languages for specific purposes classroom	Present an approach with PBL, introducing the students of the Master's degree in "Languages and Business Relations" at the University of Aveiro to two Translation Management Systems (TMS).	The Traduction Management System (TMS), providing a set of hands-on projects.



AUTHOR, YEAR, PLACE, TITLE	OBJECTIVES	STRATEGY
<p>(JIANG et al., 2020)</p> <p>China</p> <p>Teaching towards design-based learning in manufacturing technology course: Sino-Australia joint undergraduate program</p>	<p>Following the seven principles of design-based learning (DBL) to carry out a process planning project for teaching and learning in the Manufacturing Technology course.</p>	<p>Design Based Learning (DBL)</p>
<p>(GUTGARTS, 2020)</p> <p>Russia</p> <p>Practical aspects of project-based learning in the study of the discipline "developing information systems"</p>	<p>To apply the design thinking approach to students with study profiles related to the study of disciplines focused on information systems (IS) design.</p>	<p>Project-Based Learning (PBL)</p>
<p>(PORTUGUEZ CASTRO; GÓMEZ ZERMEÑO, 2020)</p> <p>Mexico</p> <p>Challenge based learning: Innovative pedagogy for sustainability through e-learning in higher education</p>	<p>Implementing Challenge Based Learning (CBL) as an innovative pedagogy through online education in this specific study group.</p>	<p>Challenge Based Learning (CBL)</p>
<p>(ZAMORA-POLO et al., 2019)</p> <p>Spain</p> <p>Developing project managers transversal competences using building information modeling</p>	<p>Analyzing the experience of PBL in projects carried out within the context of a project management course at the University of Extremadura.</p>	<p>Building Information Modeling (BIM) Methodology using Project-Based Learning (PBL)</p>
<p>(MORALES; GARCÍA, 2018)</p> <p>Spain</p> <p>Project-based learning: A university experience</p>	<p>Encourage and develop teamwork competencies, management skills and strategies, locating, researching, and evaluating information from electronic documentary sources, verifying reflection, investigations, and knowledge construction.</p>	<p>Instructions for the students to determine the problem to investigate, describe the purpose of the project, specify the design, rules, and evaluation method.</p>
<p>(VIRTANEN; RASI, 2017)</p> <p>Finland</p> <p>Integrating web 2.0 technologies into face-to-face PBL to support producing, storing, and sharing content in a higher education course</p>	<p>Present and discuss the development and implementation process of a PBL-based course, held at the University of Lapland, Finland, during the year 2014.</p>	<p>Project-Based Learning (PBL)</p>
<p>(LEAL FILHO; SHIEL; PAÇO, 2016)</p> <p>United Kingdom</p> <p>Implementing and operationalising integrative approaches to sustainability in higher education: the role of project-oriented learning</p>	<p>Explore the role of PBL and discuss how the pedagogical philosophy not only allows students to implement and enhance the skills necessary for employability, but also raises awareness about sustainable development.</p>	<p>Project-Based Learning (PBL)</p>



AUTHOR, YEAR, PLACE, TITLE	OBJECTIVES	STRATEGY
(GONZÁLEZ-CARRASCO et al., 2016)  Spain  The development of professional competences using the interdisciplinary project approach with university students	Describe the experience conducted by a group of teachers from different departments of the University of Girona (Catalonia, Spain) through an interdisciplinary work, to promote relevant skills for the professional sector.	A project should be analyzed and diagnosed from different perspectives to generate various alternative solutions.
(NTOMBELA, 2015)  South Africa  Project-based learning: In pursuit of androgogic effectiveness	Present the effort of a University in Oman to introduce PBL through a project component offered at the foundation level.	Project-Based Learning (PBL)

Source: Authors(2022).

In summary, the years 2020 and 2021 presented the highest number of studies on the researched topic. Analyzing the highlighted area, the main focus was on Social Sciences, followed by Computer Science, Environmental Science, and Engineering. Among the most representative keywords are: learning, teaching, students, education, and Project-based Learning (PBL). Spain, the United Kingdom, Russia, Portugal, Finland, and China stood out as reference countries for the application of projects as a teaching and learning strategy.

In studies that explicitly aimed to investigate the use of PBL, the specific focus was on the pedagogical approach of the course in terms of meaningful learning, development of critical thinking, acquisition of soft-skills competencies and abilities, collaborative work, and the possibility of solving real problems in the educational context (DINIS-CARVALHO; FERREIRA-OLIVEIRA, 2021; HASLAM; MADSEN; NIELSEN, 2021; HERGET, 2020; ZAMORA-POLO et al., 2019; VIRTANEN; RASI, 2017; LEAL FILHO; SHIEL; PAÇO, 2016; FERNANDES; NTOMBELA, 2015).

Portuguez Castro, Gómez, and Zermeño (2020) discussed Challenge-Based Learning (CBL), involving the application of knowledge during professional training. Fernandes, Dinis-Carvalho, and Ferreira-Oliveira (2021) conducted a study to analyze students' perception of the use of PBL through the application of the Scrum method, a project management approach.

In the next section, it is possible to see the different and innovative strategies resulting from the use of PBL as a teaching and learning methodology, as pointed out by the cited authors.

## 4 DISCUSSION

Fernandes, Dinis-Carvalho, and Ferreira-Oliveira (2021) conducted their study in the fourth year of the Integrated Master's in Industrial Engineering and Management program at the University of Minho, Portugal. The study evaluated the performance of student teams in project-based learning



with the Scrum framework. Scrum is an agile methodology developed and used in software companies to help teams manage their projects and develop effective applications to meet customer expectations. With a focus on analyzing the effectiveness of Scrum for project management in PBL teams in higher education, the authors used an exploratory case study. The perception of 92 students was conducted through an online questionnaire made available to students at the beginning and end of PBL projects. In addition, direct observation with the teams that worked on the projects, group meetings, analysis of documents (Sprint Planning, Burndown charts, Scrum boards, etc.), and informal conversations were carried out during the years 2017 to 2019. The results show that task assignment, performance monitoring, visual management, and regular feedback pointed to the main advantages of using Scrum in PBL teams, with a positive impact on student performance. For the success of Scrum, students recognize the role of the Scrum Master and the Project Owner as vital to guiding teams sustainably. According to the authors, research on the application of Scrum in education is scarce and mainly exploratory, making this study a valuable contribution to improving the performance of PBL teams with the use of agile approaches such as Scrum.

Araújo et al. (2021) applied a team-based and project-based teaching methodology, created in the context of the 'Applied Physics 50' (AP50), a course at Harvard University, USA. The objective was to increase student engagement in teaching activities, teamwork skills, self-directed learning, and professionalism. Students were organized into small, self-selected groups, guided by the professor based on real-world problems that made sense to them. Before classes, a synchronous preparatory activity was conducted, where students collaboratively read textbook pages in a flipped classroom format. Next, each of the activities was presented, indicating the pedagogical principles and ways to implement them. The proposed activities emphasized the conceptual understanding of physics concepts using peer instruction (PI) and the application of these concepts. Tutorials were made available as support for the professor, who assumed the principle that a student can learn from another and that discussions among peers foster the ability to question, listen, and identify. In detail, the authors described the pedagogical principles of AP50, as well as teaching techniques and strategies as a stimulus for reflection on the possibilities of reinventing introductory-level physics teaching, considering the specificities of each educational context. In conclusion, the authors emphasized their position in defense of the importance of differentiated pedagogical aspects and expanding horizons on what is taught, guiding the search and adoption of didactic innovations.

Martín-Garin et al. (2021) work presented education for sustainable development (ESD) as one of the great challenges that university teachers need to face. Thus, a multidisciplinary team from the Faculty of Engineering of Gipuzkoa (EIG), at the University of the Basque Country (UPV/EHU), in Spain, developed different pedagogical approaches that were applied in construction courses, namely Civil Engineering and Technical Architecture. Pedagogical tools such as problem-based learning



(PBL) or research-based learning (RBL), and environmental tools such as life cycle assessment (LCA) and computational thinking (CT) were used, following the logic that in doing so students acquire a sustainable approach to working on soft skills competencies in sustainability. The authors emphasized that research-based tools helped to revalue waste both outside and inside the university, contributing to more sustainable industrial processes, as well as academic projects and designed tools that were deemed suitable for teaching. However, to demonstrate their potential in terms of sustainable education, holistic rubrics based on in-depth quantitative educational research are needed.

A study conducted by Haslam, Madsen, and Nielsen (2021) describes how a Danish university adapted to the circumstances brought by the COVID-19 pandemic. The institution has a long tradition of using Problem-Based Learning (PBL) as the central educational principle for all student learning activities, based on the idea that students learn best while engaged in problem-solving. The study found that prior to the pandemic, programs of study focused on group projects, with semester-long projects accounting for 50% of the semester grade and consuming 50% of the students' time. The focus was on providing a social structure that would allow students to work closely with their group colleagues, apply the knowledge gained in lectures and classes, collaborate with public or private organizations to understand the complexity of the problem and the potential solution in a real-world scenario.

With the advent of COVID-19 and the need for social distancing, this traditional approach to learning became impossible, forcing the PBL groups to become digital and distributed. Through semi-structured interviews with students, teachers, managers, and the digitalization team, the authors investigated how those involved experienced the lockdown and how they adapted to distance learning, its speed, benefits, impact, and intentional consequences. They also surveyed 632 social science students about their experience with online learning and the usability of software such as MS Teams from the perspective of the IT department.

The study found that 60% of students evaluated online supervision positively, 54% evaluated live lectures positively, and 48% evaluated recorded lectures positively. However, the majority of students (60-62%) reported a preference for traditional face-to-face classes and supervision. The study also found that online learning brought various challenges related to limited social interaction, but being part of a PBL project group and collaborating digitally helped to neutralize feelings of isolation, lack of interaction, and concentration problems. Because activities continued to center around PBL projects, students met online frequently to interact with their colleagues, supervisor, and the case company. This motivation and sense of belonging helped to maintain positive interpersonal relationships, providing fundamental psychological energy and responsibility for engagement.

The study challenges the established idea that PBL requires face-to-face interaction among students in designated group rooms on campus and that digital PBL plays a more projected role in learning outcomes. The authors noted that further research during and after the COVID-19 pandemic





is needed to analyze the long-term impact of this rare event on PBL practices, including how to balance in-person and digital instruction.

The study by Portuguese Castro and Gómez Zermeño (2020) presented an innovative teaching methodology called '*Aprendizaje Basado en Desafíos (CBL)*', which involved students and put them to solve real-world challenges, while applying the knowledge acquired during their professional training. It is a qualitative case study that explores several real-life cases with observations, interviews, audiovisual materials, documents, and reports. The sample consists of 20 university students from different areas of a university in northern Mexico. During five weeks of activities, the students worked collaboratively and participated in challenges related to the United Nations' Sustainable Development Goals (SDGs), seeking solutions to social problems by proposing products and services that could be converted into entrepreneurial businesses using the e-learning modality. The information was collected through discussion forums, questionnaires, observation guides, evaluation of activities and proposed solutions. The results showed that the participants generated sustainable business ideas, oriented towards solving local, national, and global problems. The authors concluded that CBL as an innovative pedagogy presents students with multidisciplinary and specific real-world study fields and challenges, strengthening motivation to conduct research and find solutions that address the realities of their surroundings. CBL is a communication tool that facilitates collaborative work and interactions between participants at different times and places, as well as allowing the integration of innovative and low-cost communication technology tools.

Gutgarts (2020) provided an example of the use of project-based learning (PBL) elements in Soviet higher education in the specialization course "Information Technology," as well as its projection on a modern educational platform. The goal was to consider individual methodological issues and practical recommendations for the application of the PBL method for students in study profiles related to disciplines focused on information system (IS) design. The result of the study focused on the possibility of introducing interdisciplinary project-based education, in particular, the participation of students from other specializations in projects aimed at creating functional IS. The authors concluded that the introduction of project-based learning in university-level information technology education enables the resolution of distinct problems, such as: (1) the ability to respond to rapid changes; (2) redistributing functions among project participants if necessary; (3) interacting with all project participants; and (4) demonstrating creativity. They emphasized that the introduction of project-based learning in higher education cannot and should not be understood as just another process, as it will require a review of the curriculum and content of disciplines due to its scope.

As reported by Herget (2020), for many decades, higher education institutions have incorporated the use of PBL into their curricula as a response to preparing students for new professional challenges and expanding their opportunities. This article explored the implementation of two



Translation Management Systems (TMSs), Memsource and memoQ, in the language classroom and aimed to identify specific project activities that can be carried out to promote foreign language learning in the 'Languages and Business Relations' master's classroom at the University of Aveiro, Portugal. According to the author, the PBL methodology aims to add value to language learning and better prepare students for professional practice. Both Memsource and memoQ provided a set of interesting features that can be explored with the help of collaborative and problem-solving strategies in real-world scenarios, providing students with knowledge in a different field of study and promoting the creation of transversal competences. Both TMSs provided an ideal work environment for practical project management activities, as all stakeholders have the possibility to interact and gain work experience by carrying out a set of practical exercises. The classroom activity described aimed to familiarize students with TMSs and provide them with a basic understanding of the workflow of a translation project. Given the importance of adopting PBL methodologies in higher education settings, the exploration of how TMSs can be used in the language classroom to increase student language proficiency is an interesting research question that deserves further exploration by the authors.

Jiang et al. (2020) used a Design-Based Learning (DBL) approach for students in a joint degree program facilitated by the Wuhan University of Science and Technology in China, along with Deakin University (DU) in Australia. DBL is a form of inquiry-based learning that integrates design thinking and design processes in the classroom to enhance 21st-century skills such as communication and collaboration, promoting deeper learning. DBL, being an active, collaborative, and integrative teaching methodology, is used in various engineering courses. It is a self-directed approach that starts with the student's learning process, with the teacher as a supervisor. DBL is a form of project- or problem-based learning where students work in teams to gain knowledge while designing a meaningful solution (object, artifact, or report). It involves collecting information, identifying a problem, suggesting ideas to solve it, and evaluating solutions. Once students have chosen the problem to focus on, they design a solution to solve it. Finally, students receive feedback on the effectiveness of their project, both from the facilitator and other participants. The authors focused on the seven general principles of DBL (clear concepts, problem definition, problem analysis, identifying possible solutions, defining the task set, researching for a solution, and synthesizing the results achieved) and conducted a process tutoring planning project in the Manufacturing Technology course. Many awards were won by the students, demonstrating satisfactory results in the case study on teaching practice with DBL. The authors concluded that the pedagogy with DBL improves the quality of teaching in joint courses and programs, further strengthening the internationalized engineering education for sustainable development of regional universities in China.

Zamora-Polo et al. (2019) analyzed a PBL experience carried out in the context of a project management course at the University of Extremadura in Spain. The project included an environmental



impact study and a health and safety study based on the analysis of a technical project using the BIM (Building Information Modeling) methodology. Students were required to understand the advantages and disadvantages of BIM tools and methodologies, create a construction project and its complete documentation, and integrate the information into a digital model, detecting conflicts, defining schedules, and simulating costs. The activity was carried out by groups of four students (two from mechanical engineering, one from electronics, and one from electrical engineering), totaling 66 project participants. The results suggested that BIM can be considered a virtual learning environment from which students value the transversal competencies developed, as well as bring potential benefits to project management. The observed emotional performance was quite positive, and in the future, students will be able to manage negative emotions such as anxiety, fear, and frustration. The authors concluded that the students valued the usefulness of the initiative, expressing a desire for a methodological change in university classes, and found that the BIM methodology could be useful for other courses. The results obtained showed a line of work to be done to improve student training and university teaching.

Morales and Garcia (2018) conducted an innovation experiment with 107 students from the Early Childhood Education undergraduate program at the University of Seville, Spain. The experiment involved the use of PBL methodology, a teaching strategy in which students plan, implement, and evaluate projects that have real-world applications, going beyond what happens in university classrooms. For the authors, PBL is a student-centered methodology that makes them protagonists of their own learning. The objective was to promote and develop competencies related to teamwork, management strategies, research, and evaluation of information contained in electronic documents for the construction of knowledge. The 107 students belonged to different classes, with group 1 composed of 56 students and group 2 composed of 51, forming 30 small work groups of three or four participants. A series of elements were organized and directed to guide each phase (problem to investigate, project purpose, specifications, rules, and evaluation), what the teacher's role should be, and what results were expected to be achieved. The results showed that 70.6% of the students in group 1 and 84.6% of group 2 achieved a notable qualification in the development of projects, indicating that PBL has a positive effect on fundamental knowledge and the construction of skills such as collaboration, critical thinking, and problem-solving, as well as an increase in motivation and commitment of students. Among the main advantages of this type of methodology, the authors listed the level of student satisfaction, as well as the creation of a positive learning environment.

In the article entitled "Integrating web 2.0 technologies into face-to-face PBL to support producing, storing, and sharing content in a higher education course", Virtanen and Rasi (2017) presented and discussed the development and implementation process of the "Moving Images in Teaching and Learning" course based on PBL, which was carried out at the University of Lapland in



Finland. Throughout the project, the traditional face-to-face course was redesigned as a mixed PBL course, integrating Web 2.0 applications. The pedagogical logic was to support students' meaningful learning in various phases of the PBL process and to allow for easy storage and sharing of ideas produced in groups. A questionnaire including 30 questions about processes, resources, and learning evaluations was presented to the students, as well as questions that evaluated the experienced emotion, the main reasons for experiencing the emotion, and interviews about previous experiences with PBL and Web 2.0. The idea was to create more opportunities for students to report their process during independent knowledge acquisition and for the teacher to monitor and support students' information-seeking processes. The authors pointed out that characteristics of meaningful learning, collaboration, cooperation, and conversation were favorably evaluated. Although all students in the course agreed that they were in an active role, they realized that this role was not always fulfilled in practice when students arrived at the session without preparation and prior knowledge acquisition. Furthermore, students critically evaluated self-direction, including time management skills.

The concept of sustainable development has gained significant attention since the Brundtland Report. Higher education institutions worldwide have increasingly emphasized the acquisition of a broader range of skills or attributes within the taught curriculum, which should lead students to a widening of their chances of academic success, particularly in the job market. Among others, issues related to sustainable development play a fundamental role, but many universities still do not adopt integrative approaches that can help them address sustainability issues in a transformative manner. With the aim of exploring the role of PBL and discussing the pedagogical philosophy for promoting awareness of sustainable development, the study entitled "Implementing and operationalizing integrative approaches to sustainability in higher education: the role of project-oriented learning" was structured. Data collection occurred in three stages, a secondary survey to understand the processes used in PBL, analysis of documented case studies, and personal contacts with potential examples that were identified. The authors concluded that PBL is a valuable pedagogical approach, but it requires the selection of appropriate projects, with support for students seeking more sustainable and innovative solutions, while enhancing the knowledge and skills of participants. Furthermore, experiential learning, in real-world scenarios, allows the development of competencies that will not only be valued in the workplace, but vital if the world wants to rectify sustainable development. (LEAL FILHO; SHIEL; PAÇO, 2016).

González-Carrasco et al. (2016) described an experience conducted by a group of teachers from different departments at the University of Girona, in Catalonia (Spain). This experience arose from the need to develop interdisciplinary work in order to promote relevant competencies for the professional sector. Undergraduate students from different courses were challenged to work collaboratively and interdisciplinarily on a project related to the management of a school canteen. The objective was to



promote the development of competencies closely associated with the professional world, such as teamwork and problem-solving through a contextualized project that required interdisciplinarity. For two years, the teachers met to organize an activity that involved collaborative work in an educational project based on PBL methodology. The structuring was based on the discursive logic of WHAT (specific objectives and necessary strategies), HOW (definition of the key elements that the proposal should contain), and WHY (experimenting and obtaining the maximum individual and teamwork performance). Two levels were specified, namely: the first required students to develop a management model for the school cafeteria, with changes in the food model and activities offered; the second was defined as the Messi Project of Vall d'Aro (in Catalan, meaning sustainability). The project was developed over two months and completed after four joint work sessions of 2 hours between teachers and students, involving 22 students, including five from the agri-food program, four from industrial engineering, four from medicine, and five from psychology. The activity showed that it is feasible to carry out innovative, contextualized, real-life, and interdisciplinary research, as it allowed students to structure and organize their knowledge through problem-solving, resulting in greater retention and understanding of the studied knowledge and its practical application. According to the authors, this type of environment helps students understand why, how, and when they can apply their knowledge, contributing to increasing student motivation and commitment to their team.

In an attempt to standardize the Fundamental Programs for higher education providers in Oman, providers should offer programs that ensure andragogical effectiveness. The term andragogy comes from the Greek word "aner" with the root "andra", which means man, or adult, and "agogos", which refers to leader, being widely known as 'the art and science of helping adults learn'. In light of this, Ntombela (2015) presented the attempts of a University College in Oman to introduce the PBL methodology, since recent graduates demonstrated a deficiency in soft skills. As a result, the project was designed with the aim of achieving learning outcomes such as teamwork, meeting deadlines, critical thinking, and research skills. These projects focused on: (i) Employee Portrait Gallery, in which students collected information about college employees they interviewed; (ii) Brochure aimed at communicating the research results that students conducted around a university theme, such as Road Safety; and (iii) Class Magazine that presents information collected through interviews and research on university topics that should be presented in an informative and fun way. Most importantly, the project relied heavily on the six-step approach that supported the delivery and learning mode, namely: think - brainstorming through spider diagram; research - retrieving information through interviews, research, internet, library, among others; plan - categorization, ensuring only relevant information is recorded; record - recording stage, writing, contributing as a group; edit - treating texts, errors and corrections, first by students and then by the teacher; and present - demonstrating the final product, ensuring compliance with expectations. This process required a change in the traditional role of the



teacher as the center of the learning process to that of students who took responsibility for their learning. According to the author, andragogical principles are not only true for adult learners but apply equally to most students in general. However, the project, in this case, is not an approach, but a subject, the chances of transferring skills to other components are compromised; and also because projects are largely initiated by teachers, andragogical principles seem compromised.

## 5 CONCLUSION

The literature review from this scope review allowed us to observe that the current educational context seems to emphasize that the teaching and learning process should be student-oriented, and that the teacher should act as a mediator, observer, and questioner, leading the students to rethink their acquired knowledge.

The project-based approach is an inductive approach that underlies the principles of PBL. This is demonstrated by the increase in 21st-century skills, reported by different authors, who seek to equip students with a modern, work-oriented learning approach. Although not an easy methodology to apply, the results obtained can be demonstrated by high student satisfaction and excellent interactions with teachers, creating a positive learning environment.

It is also noteworthy that the interdisciplinary nature of the project increased student motivation and commitment to other team members, as well as building relevant competencies for the professional world, fulfilling the main characteristic of competency-based education, which integrates disciplines, knowledge, goals, practices, and values for good professionals.

In summary, PBL is a teaching strategy where students plan, implement, evaluate, and apply their projects in the real world, far beyond the university classroom. It is an innovation that when put into practice fosters and develops a variety of competencies, mainly related to teamwork, management skills, research, evaluation of information, and above all, knowledge construction.



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## APPENDIX A - Studies not eligible for the sample with respective description.

AUTHORS	DESCRIPTION
(AZEVEDO et al., 2022)	Apresentation and description at the MathE Plataform for use and learning environment.
(CUNHA et al., 2022)	Assessment of the long-term impact of the course, focusing on identifying relevant metrics that characterize the career evolution and professional status of former students.
(FEIXAS; MARTÍNEZ-USARRALDE, 2022)	Research case study on the transfer of assessment to teaching innovation projects, based on an interview and discussion group.
(JÄÄSKÄ; AALTONEN, 2022)	Semi-structured qualitative interviews, data analysis, to gain understanding of teachers' perceptions on the application of game concepts in the educational context of project management.
(MELGUIZO-GARÍN et al., 2022)	Application of questionnaires to measure undergraduate students' group work skills, using the PBL methodology.
(ALAMRI, 2021)	Research on the perception of the potential use of PBL and combined learning, through the application of a questionnaire that assesses the perceived self-efficacy, pleasure and usefulness of the approach
(AL-BUSAIDI; AL-SEYABI, 2021)	Research study based on students' perception of the project-based approach to teaching design principles as part of the undergraduate educational curriculum.
(ÁLVAREZ et al., 2021)	The study focuses on the evaluation, through a questionnaire, of the incorporation of SDGs in the curricular trajectory of the civil engineering course, supported by PBL.
(DÍAZ; GARCÍA; HERNÁNDEZ, 2021)	Theoretical studies on project planning, negotiation skills, teamwork, among others, using the logical framework approach (LFA).
(DINCĂ et al., 2021)	Research carried out together with a collaborative project to better understand the different characteristics of a group dynamics in relation to the composition of the disciplinary group, a mixed methodology.
(GALVÃO et al., 2021)	Focus on the contribution level of doctoral students to the resolution of sustainability problems, based on the research perspective.
(MIELMANN, 2021)	Case study analysis, structured questionnaire and student engagement survey.
(NGUYEN, 2021)	Analysis of data collected on student responses to activities used to check knowledge, group work, team involvement, communication skills, and project management skills.
(PUENTE et al., 2021)	Theoretical study on a project that analyzes the implementation of learning services in an engineering course, with social impact.
(ROYLE, 2021)	The study brings a set of findings on the use of PBL from interviews in semi-structured groups, with students and staff of undergraduate courses in arts and sciences in the Palestinian context.
(ABUHMAID, 2020)	Research carried out through a questionnaire to examine the impact of the online learning environment on the implementation of PBL, using a post-test with an experimental group and a control group.
(ARÁNGUIZ et al., 2020)	Qualitative analysis of pedagogical results linked to the development of critical thinking in project-based learning.



AUTHORS	DESCRIPTION
(FEIXAS et al., 2020)	Use of interview techniques to verify students' perception of collective projects.
(GRANADO-ALCÓN et al., 2020)	Exploratory cross-sectional study based on a questionnaire to identify the perception of academics in the acquisition of competences through PBL.
(MIHAELA; AZTEFANIA, 2020)	Study based on interviews that analyzes the challenge of preparing teachers and researchers to implement PBL.
(PEDERSEN; HOBYE, 2020)	Use of a single case study to explore problems with a focus on raising reflections on evaluative practice, not limited to bringing a discussion on the use of projects.
(SALMINEN-TUOMAALA; KOSKELA, 2020)	Exploratory qualitative study, using a questionnaire, which sought to describe the experiences and views of university professors on simulation as a teaching and learning method.
(ALMEIDA; SIMOES, 2019)	The study used the results of 25 innovative projects, with educational practices that include games and emerging practices in IoT, AR, big data and cloud computing for data investigation and comparative analysis of results.
(CAZORLA-MONTERO; DE LOS RÍOS-CARMENADO; PASTEN, 2019)	Application of a self-assessment questionnaire focused on the perception of the teams after implementing the planning and sustainable development program in graduate programs.
(HÖGFELDT et al., 2019)	The study describes, evaluates and discusses a participatory implementation project of challenge-oriented education, focusing on Activity Theory (AT)..
(KUMPULAINEN; VIERIMAA; KOSKINEN-KOIVISTO, 2019)	Study of the social interactions, behaviors and perceptions that occur within groups, teams, organizations and communities, with a focus on connective pedagogy and culture.
(STRACHAN et al., 2019)	The study is configured as a report and focuses on sharing the experience of incorporating research-based education for sustainable development and the use of innovative pedagogy in vertically integrated projects.
(PALAZUELOS et al., 2018)	Descriptive approach based on the analysis of students' perception of PBL and on the demonstration of positive effects on knowledge.
(STOKES; HARMER, 2018)	Activities developed with a focus on testing three learning theories (experiential learning, constructivism and transformative learning) and investigating, using interviews, the findings applied to projects from the perspective of the participating groups.
(AUSÍN et al., 2016)	Application of a questionnaire to assess the appreciation of students with the project carried out in the course.
(HUBER; HARVEY, 2016)	Analysis of final project reports and interviews with leaders (systematic review)
(RODRÍGUEZ-SANTERO; TORRES-GORDILLO; PERERA-RODRÍGUEZ, 2016)	Opinion poll based on a questionnaire on different aspects of the PBL methodology.
(IMAZ, 2015)	Development of a project based on the analysis of a social context, an exercise in applied sociology.
(SMITH; THONDHLANA, 2015)	Research done by a study group to assess demands of an undergraduate group case study, focusing on the task analysis framework used to examine project documents.



AUTHORS	DESCRIPTION
(STOZHKO et al., 2015)	Application of tests to assess the cognitive level regarding the quality and results of the learning process.
(DICKERSON; JARVIS; LEVY, 2014)	Evaluation of a project focused on increasing support for academic reading at the master's level, using blended learning.
(JOYCE et al., 2013)	Feedback from a strategy describing the transition from a paper-based exercise to one based on a building design project, treated as a pedagogical approach.
(TORRES GORDILLO, 2010)	Application of a valuation test to know the results of the implementation of PBL, with a focus on psychopedagogical intervention.

Source: Authors (2022).