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Systematic Review

Systematic Review: Revisiting Challenge-Based Learning Teaching Practices in Higher Education

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Abstract: In recent years, Higher Education institutions have reviewed learning and teaching methodologies to align competencies with evolving socioeconomic scenarios. Challenge-Based Learning (CBL) has emerged as a key method for developing competencies and self-regulating capacities in university students. This study aimed to identify the teaching practices associated with CBL in Higher Education. Adhering to PRISMA 2020 guidelines, this systematic review analyzed open-access and peer-reviewed publications from 2013 to 2023. The selection process reviewed 64 articles from Web of Science (WoS) and Scopus. To assess the risk of bias, the Delphi method with expert panels from the University College of Northern Denmark (UCN) was used. The review identified 20 studies emphasizing a shift in teaching practices in CBL toward student-centered learning, categorized into four key dimensions: pedagogical approaches, technological integration, industry engagement, and support for development. These findings illustrate the transition from traditional teaching to facilitative roles that foster innovative problem-solving. Limitations included the scarcity of research on specific CBL teaching practices and detailed implementation strategies, highlighting the need for further research. This study underscores the importance of specialized educator training in addressing CBL adoption challenges and preparing students for complex future challenges, enhancing student learning and growth across disciplines.

Keywords: systematic literature review; Challenge-Based Learning (CBL); teaching practices; Higher Education

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1. Introduction

Within the continuously evolving domain of Higher Education, there is an imperative demand for pedagogical innovations that not only facilitate academic excellence but also equip students to navigate the complexities of today's global and professional landscapes. Challenge-Based Learning (CBL) has been acknowledged for its efficacy in augmenting student learning outcomes and enhancing problem-solving capabilities [1]. However, a significant research void exists concerning explicit teaching practices within CBL, particularly those aimed at fostering an entrepreneurial mindset in the Higher Education sector. Leijon et al. identified 36 articles that focused on CBL over an 11-year period [2]. However, comprehensive insights into specific teaching practices remain scarce.

This systematic review aims to bridge this gap by synthesizing the limited existing research, delineating the teaching practices most prevalently associated with CBL, and focusing on their contribution toward cultivating entrepreneurial acumen and innovative skills among students. By accurately examining the current literature, this review intends to identify emergent patterns and pinpoint areas for further scholarly exploration. This will provide educators, curriculum developers, and policymakers profound insights into the efficacy and challenges inherent in the implementation of CBL.

CBL is conceptualized as an innovative pedagogical strategy that involves immersing students in real-world problems that require collaborative, creative, and critical thinking for resolution. Scholars, such as Gyldendahl et al. [3] and Gallagher and Savage [4], highlight that CBL prioritizes experiential learning and the practical application of knowledge. This method contrasts with traditional education by centering students in the learning process and encouraging them to play an active role in their educational journey [5,6]. CBL aims to equip students with essential modern skills, including critical thinking, problem-solving, teamwork, and digital literacy [7,8].

1.1. Entrepreneurial Mindset and Innovative Capabilities

Innovation in CBL encompasses both a mercantile aspect, focusing on creating new surplus value [9], and a social innovation aspect aimed at generating social, cultural, and interpersonal values [10]. These dimensions underscore the importance of addressing real-world challenges for innovative solutions.

Carl Otto Scharmer [11] emphasized that significant innovation entails action rather than merely conceptual discussions, aligning with CBL's emphasis on actionable solutions and the application of knowledge to practical challenges [11]. As defined by Sørensen and Torfing [12], this process involves identifying challenges, developing new ideas, and implementing solutions. This dynamic interaction between innovation competencies and entrepreneurship is crucial for CBL.

Higher Education plays a critical role in fostering students' entrepreneurial skills and innovation. Developing competencies, such as initiative and collaborative ability [13], and fostering self-efficacy [14] are essential. Teachers with strong instructional efficacy significantly impact the learning environment, motivate students, and build beliefs regarding their capabilities to overcome challenges.

1.2. Teaching Practices

Teaching practices are recognized for their dynamic, social, and evolving nature [15]. These are collective constructs born from the interplay of actions, knowledge, skills, and habits [16,17]. In the CBL context, educators shift toward facilitation, guiding students through complex challenges and promoting a learning environment that encourages engagement and solution finding [18]. Educators in CBL are responsible for guiding the formulation of challenges, selecting resources, and providing timely feedback [19,20]. Their adaptability was notably tested during the COVID-19 pandemic as they transitioned to online learning and adjusted their teaching methods to maintain educational efficacy [21].

Identifying teaching practices within CBL is crucial for several reasons. First, it provides educators with a clear understanding of pedagogical strategies that are most effective in CBL environments. This insight is vital for fostering an educational atmosphere in which students can meaningfully engage in real-world challenges. Second, recognizing these practices helps standardize CBL approaches across educational settings, ensuring consistent and high-quality learning experiences for students. Third, these practices guide educators in transitioning from traditional teaching methods to more interactive student-centered approaches, which are the cornerstone of CBL. By identifying these practices, educators can tailor their teaching methods to facilitate critical thinking, collaboration, and problem-solving skills, which are key competencies in today's rapidly evolving world.

Despite the growing implementation of CBL, a significant knowledge gap remains regarding the specific teaching practices employed by educators. Previous studies have identified various aspects of CBL but have not comprehensively categorized the teaching practices used in Higher Education. This gap indicates the need for a detailed exploration of these practices to effectively support educators in implementing CBL.

Considering the evolving educational landscape, the purpose of this review is to nurture entrepreneurial skills and mindsets among Higher Education students. CBL has gained recognition as a viable strategy to accomplish this objective, and educators are exploring its potential as a substitute for conventional teaching methods. Thus, it is essential to investigate the practices employed by educators who have successfully integrated CBL into their Higher Education curriculum. This review aims to delve deeper into the CBL teaching practices in Higher Education. Therefore, we formulated the following research question:

RQ: Which teaching practices associated with Challenge-Based Learning (CBL) are identified in scientific and peer-reviewed publications in the context of Higher Education?

2. Materials and Methods

2.1. Protocol

This study rigorously adhered to the PRISMA 2020 guidelines for conducting a systematic literature review, following each prescribed step and using the checklist (see File S1) to ensure a comprehensive and unbiased analysis [22].

Prior to initiating the review, a detailed protocol was prepared, specifying the scope of the review and research question [23,24]. This preparatory work was essential to pre-specify, plan, and document the key elements of the systematic review methodology, including the PICO framework, primary outcomes, eligibility criteria, and search strategies [25]. This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 31 May 2024 and was last updated on 31 May 2024. The registration number is INPLASY202450140. The DOI number is https://doi.org/10.37766/inplasy2024.5.0140.

The protocol of this review is outlined in "Protocol for Systematic Review: Revisiting Challenge-Based Learning-Teaching Practices in Higher Education" [24].

2.2. Eligibility Criteria, Information Sources, and Search Strategy

Essential for inclusion were articles that contained "teacher in Challenge-Based Learning" in their content, focused on Higher Education, were published in English in reputable journals, and were full open-access and peer-reviewed papers.

When conducting a literature review, it is essential to choose the right databases such as Web of Science (WoS) and Scopus. These databases have numerous benefits for scholarly research. WoS is renowned for its comprehensive coverage of high-impact journals and precise indexing, making it an invaluable resource for accessing a broad range of academic disciplines. In contrast, Scopus offers a vast collection of multidisciplinary content and provides powerful search capabilities, including the ability to search within article titles, abstracts, and keywords. The decision to utilize these databases was motivated by the necessity of accessing an extensive collection of peer-reviewed literature and conducting a thorough and comprehensive examination of the scholarly realm [24], particularly considering the wide variety of publication platforms that exist in the social sciences [26]. Utilizing these databases enables researchers to perform thorough and extensive literature reviews, thereby enhancing the credibility and quality of their findings.

In this study, the term "teacher in Challenge-Based Learning" was used as a search query in the Scopus and Web of Science (WoS) databases, covering the period from January 2013 to October 2023. The chosen start date for the search was based on the first article published on the topic that met the inclusion criteria mentioned in the previous sections, with the end date being the day the search was conducted.

The WoS database search was configured to specifically search within the Web of Science Core Collection in the "All Fields" edition, which allows for exploration across all search fields using a single query. This facilitated the identification of search terms in various fields. Additionally, the asterisk (*) character was utilized within the term "teacher", enabling the substitution of any number of characters both before and after the keyword. The rationale for using the "All Fields" edition and the asterisk (*) lies in maximizing the comprehensiveness of the search, ensuring that potentially relevant literature is not overlooked by examining multiple fields and accommodating variations in terminology or phrasing related to "teacher". The search query in WoS was ALL=(teacher* in Challenge-Based Learning). The refining filters used only included open-access documents and peer-reviewed papers. Additionally, the search period was restricted to documents published between 1 January 2013 and 7 October 2023, which was the date of the initial search.

For the search conducted in Scopus, the option to search within "Article title, Abstract, Keywords" was selected, and the AND search query used was "teacher* AND in AND Challenge-Based AND Learning". Filters were applied to limit the search to the years 2013 to 2023, with results restricted to English-language articles and further refined to include only documents classified as "All open access".

2.3. Selection Process

The selection process involved a thorough review of titles, abstracts, and full texts based on strict inclusion criteria, beginning with an initial haul of 37 articles from the Web of Science (WoS) and 27 from Scopus, totaling 64 records. Essential for inclusion were articles that contained "teacher in Challenge-Based Learning" in their content, focused on Higher Education, were published in English in journals, and were full open-access and peer-reviewed papers.

To ensure the quality of the selected articles, it was crucial that they met the established eligibility criteria, particularly by being indexed in WoS and Scopus and by being published in peer-reviewed, open-access journals. WoS and Scopus provide superior quality indexing and bibliographic records in terms of accuracy and control compared with other specialized databases [27]. Individual journals were not evaluated based on their impact factor or other ranking systems; instead, the focus was on their inclusion in these databases, which provided baseline assurance of quality and accessibility.

This approach minimized the risk of study bias, guiding the evaluation of each paper to ensure a rigorous bias assessment. Of the initial collection, 21 articles were removed because of duplication and another 23 were excluded based on specific criteria: studies outside Higher Education contexts, non-English publications, and articles not addressing Challenge-Based Learning (CBL). This screening, depicted in the PRISMA 2020 flow diagram (Figure 1), streamlined the selection process and clearly demonstrated a systematic approach for identifying relevant studies for inclusion.

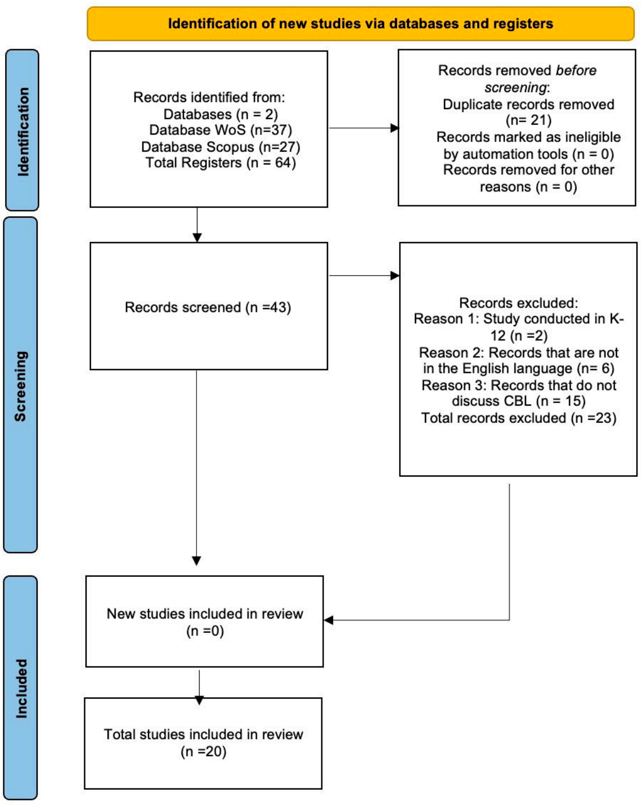

Figure 1. Flow diagram. Note: Adapted from Page et al. [22] and Haddaway et al. [28].

Regarding the search and selection phases, the process entailed a comprehensive screening of publications, starting with their titles, followed by a detailed examination of their abstracts and a thorough review of the full text. Data extraction was performed methodically, and relevant information was collated and organized for analysis.

2.4. Analysis

Thematic analysis was performed on the 20 records [29,30]. This analysis employed a systematic approach using a thematic matrix that initially included predefined themes, such as the definition of CBL and teaching practices. As the analysis progressed, additional themes that emerged were also integrated as they were found to be relevant to understanding research on teaching practices in CBL (e.g., role of teacher, role of student).

Each study underwent a careful examination conducted by the researchers. During this process, the team recorded the text passages and personal annotations pertinent to each theme within the matrix. This systematic approach enabled the methodological evaluation of each theme across the entire body of the reviewed literature.

The matrix was constructed using a Microsoft Excel sheet, and Zotero was utilized to create a complete repository of the literature and to enable searches within the full-text versions of the articles. This matrix includes the list of all included and excluded articles (n = 43). The total number of records excluded was 23 (n = 23), resulting in a total of 20 articles included (n = 20). Subsequently, information from the final group of 20 papers, which were accurately organized and structured within the thematic matrix, underwent a comprehensive review and analysis.

In addition, a list of variables was identified and defined for which data were sought, including the country in which the study was conducted, context such as the level of education, the field of degree, the format of CBL methodology implementation (e.g., presential or online), and the study design. Any assumptions made regarding missing or unclear information were considered carefully. This list of characteristics, detailed in Table 1, highlights the diversity of studies conducted across different countries employing various research designs, all within Higher Education. It also reflects the range of implementation formats and fields of study of the articles examined in this systematic literature review.

Table 1. Principal features of examined studies.

	Reference	Title	Country	Context	Study Design
1	Abril-López et al. [31]	How to Use Challenge-Based Learning for the Acquisition of Learning to Learn Competence in Early Childhood Preservice Teachers: A Virtual Archaeological Museum Tour in Spain	Spain	Education level: Higher Education Field of degree: Teaching and learning of social sciences and teaching and learning of natural sciences with early childhood preservice teachers Format: Presential	Quantitative, quasi-experimental design
2	Agüero et al. [32]	Challenge based learning as a professional learning model. Universidad Europea and Comunica +A program case study	Spain	Education level: Higher Education Field of degree: Advertising communication degree Format: Presential	Qualitative, questionnaire data
3	De Aldecoa and Gómez-Trigueros [33]	Challenges with Complex Situations in the Teaching and Learning of Social Sciences in Initial Teacher Education	Andorra	Education level: Higher Education Field of degree: Bachelor's degree in teaching and learning Format: Presential	Qualitative.

Table 1. *Cont.*

	Reference	Title	Country	Context	Study Design
4	De Stefani and Han [34]	An Inter-University CBL Course and Its Reception by the Student Body: Reflections and Lessons Learned (in Times of COVID-19)	Austria, France, Germany, Italy, Lithuania, Norway, and Spain	Education level: Higher Education Field of degree: Many disciplinary fields, including social sciences and natural sciences Format: Online	Qualitative
5	Dieck-Assad et al. [35]	Comparing competency assessment in electronics engineering education with and without industry training partner by Challenge-Based Learning oriented to sustainable development goals	Mexico	Education level: Higher Education Field of degree: Mechatronics engineering, digital systems and robotics engineering, biomedical engineering, and other engineering such as innovation engineering Format: Presential	Quantitative
6	Franco et al. [36]	Challenge-Based Learning approach to teach sports: Exploring perceptions of teaching styles and motivational experiences among students teachers	Spain	Education level: Higher Education Field of degree: Physical activity and sport sciences Format: Presential	Quasi-experimental study with experimental and control groups
7	Gaskins et al. [37].	Changing the Learning Environment in the College of Engineering and Applied Science Using Challenge Based Learning	USA	Education level: Higher Education Field of degree: Department of biomedical, chemical, and environmental engineering Format: Presential	Experimental design
8	Gudoniene et al. [7].	A Case Study on Emerging Learning Pathways in SDG-Focused Engineering Studies through Applying CBL	Lithuania	Education level: Higher Education Field of degree: Engineering education Format: Presential	Qualitative, case study
9	Khambari [38]	Instilling innovativeness, building character, and enforcing camaraderie through interest-driven Challenge-Based Learning approach	Malaysia	Education level: Higher Education Field of degree: Educational technology course Format: Presential	Qualitative
10	Kohn Radberg et al. [39]	From CDIO to Challenge-Based Learning experiences-expanding student learning as well as societal impact?	Sweden	Education level: Higher Education Field of degree: Engineering degree Format: Presential	Qualitative, case study
11	López-Caudana et al. [6].	A Personalized Assistance System for the Location and Efficient Evacuation in Case of Emergency: TECuidamos, a Challenge-Based Learning Derived Project Designed to Save Lives	Mexico	Education level: Higher Education Field of degree: Telecommunications and electronic systems engineering Format: Presential	Experimental design

Table 1. *Cont.*

	Reference	Title	Country	Context	Study Design
12	Membrillo-Hernández et al. [40]	Challenge-Based Learning: The Case of Sustainable Development Engineering at the Tecnologico de Monterrey, Mexico City Campus.	Mexico	Education level: Higher Education Field of degree: Sustainable development engineering Format: Presential (i-week and i-semester)	Experimental design
13	Mesutoglu et al. [41]	Exploring multidisciplinary teamwork of applied physics and engineering students in a Challenge-Based Learning course	Netherlands	Education level: Higher Education Field of degree: Applied physics and engineering Format: Presential	Qualitative, case study
14	Meyer [42]	Teachers' Thoughts on Student Decision Making During Engineering Design Lessons	USA	Education level: Higher Education Field of degree: Engineering design Format: Presential	Mixed methods
15	Nguyen et al. [43]	Identifying struggling teams in online Challenge-Based Learning	Netherlands	Education level: Higher Education Field of degree: Financial technology course Format: Online	Qualitative, questionnaire data
16	Nizami et al. [8]	Challenge-Based Learning in Dental Education.	China	Education level: Higher Education Field of degree: Dental education	Conceptual design
17	Pepin and Kock [5]	Students' Use of Resources in a Challenge-Based Learning Context Involving Mathematics	Netherlands	Education level: Higher Education Field of degree: Mechanical Engineering, data science, industrial engineering, psychology, and technology Format: Online	Qualitative, case study
18	Piccardo et al. [44]	Challenge-Based, interdisciplinary learning for sustainability in doctoral education.	Finland and Sweden	Education level: Higher Education Field of degree: Life sciences, physical sciences and engineering, and social sciences and humanities Format: Presential	Qualitative, questionnaire data
19	Tang and Chow [45]	Learning Experience of Baccalaureate Nursing Students with Challenge-Based Learning in Hong Kong: A Descriptive Qualitative Study	China	Education level: Higher Education Field of degree: Nursing program Format: Presential	Qualitative
20	Van den Beemt et al. [1]	Taking the Challenge: An Exploratory Study of the Challenge-Based Learning Context in Higher Education Institutions across Three Different Continents	Mexico, Netherlands, Ireland, and China	Education level: Higher Education Field of degree: Engineering education Format: Presential	Comparative case study

Furthermore, in a systematic literature review, publishing data in a repository is crucial for enhancing the transparency, reproducibility, and utility of research. This process not only facilitates the verification of results but also enables other researchers to reuse the data for new analyses and secondary studies [46]. The dataset compiled in the matrix for this review is available in the CORA repository, which ensures accessibility for further scholarly exploration [47].

2.5. Study Risk of Bias Assessment

A thorough synthesis of the findings was conducted to ensure the trustworthiness of the review, with the results presented in a transparent, systematic, and reproducible manner, fully adhering to the PRISMA 2020 guidelines. This method offers a clear and comprehensive overview of the current research on teaching practices within CBL in Higher Education. To maintain rigor and clarity, the study employed the Delphi method [48], involving expert panels for a "Certainty Assessment" of CBL teaching practices.

A confidence checklist (see File S2) was used by ten educators from the University College of Northern Denmark (UCN) to provide a robust evaluation, enhancing the study's validity and completeness. The process began by selecting an expert panel with significant CBL expertise, followed by outlining the specific outcomes for evaluation. Experts then independently assessed the certainty of the evidence for each teaching practice. Their responses were synthesized into a unified summary, ensuring a broad perspective on collective certainty regarding CBL practices.

Finally, any disagreements among the experts were addressed to reach consensus, ensuring that the assessments accurately reflected a cohesive expert opinion on the efficacy of CBL teaching practices.

3. Results

After the analysis of the 20 studies, diverse findings are presented in this section. In Section 3.1, the perspectives of each author on teaching practices are introduced. To enhance readability, a table summarizing general perspectives was prepared, organizing them into viewpoints shared across various studies.

In Section 3.2, the data are organized methodically. This organization resulted in the findings being categorized into four distinct educational dimensions: "pedagogical approaches", "technological integration", "industry and professional engagement", and "support and development". This categorization offers a structured and coherent framework to comprehend the multifaceted aspects and impacts of these studies, aligning them with crucial educational themes pertinent to the research question. The systematic arrangement of these dimensions enables a deeper and more comprehensive understanding of the findings and highlights their relevance to wider academic discussions. Finally, in Section 3.3, the core teaching practices in Challenge-Based Learning are presented, drawing together the essential practices that underpin CBL implementation, as revealed in the analyzed literature, and their interconnections.

3.1. Teaching Practice Insights from Each Reviewed Paper

In this section, various viewpoints of the authors regarding teaching methods are systematically examined. To enhance clarity and facilitate reading, a comprehensive table, referred to as Table 2, has been prepared. This table concisely summarizes the general perspectives on teaching practices derived from different articles, organizing these insights based on shared viewpoints among the studies examined. Authors using similar approaches were grouped into a streamlined data presentation. For those seeking an in-depth, author-by-author exploration of these teaching practices, an extended analysis is available in File S3, providing a more detailed understanding of each author's perspective.

After presenting a general perspective, the dimensions identified in the examined articles were outlined.

Table 2. Perspectives on teaching practices from reviewed articles.

Authors	Perspectives on Teaching Practices in CBL
Abril-López et al. [31]; Dieck-Assad et al. [35]; Gaskins et al. [37]; Van den Beemt et al. [1]	Emphasize the teacher's role as a facilitator and guide, integrating support with resources to enhance students' autonomous learning, critical thinking, problem-solving, and readiness for future challenges. Mention the need for teachers to adapt teaching strategies and develop "learning to learn" competencies.
Agüero et al. [32]; De Stefani and Han, [34]; Tang and Chow [45]	Highlight the transition from knowledge source to facilitator, fostering a collaborative, participatory experience and preparing students for professional demands through the integration of theory and practice.
De Aldecoa and Gómez-Trigueros [33]; Mesutoglu et al. [41]	Discuss the multifaceted role of teachers in promoting interdisciplinary work and guiding students through social challenges using ICTs, enhancing digital competencies, and involving students in decision-making and innovative solution development.
Franco et al. [36]; Gudoniene et al. [7]; Meyer [42]; Nguyen et al. [43]	Describe the adaptive roles of teachers in enhancing engagement, supporting autonomy, and balancing structured support with student-led learning. Stress the importance of training for teachers and professional development.
Khambari [38]; López-Caudana et al. [6]; Membrillo Hernández et al. [40]; Nizami et al. [8]; Piccardo et al. [44]	Focus on the critical importance of tutors as resources themselves, organizing project implementation, connecting students with external stakeholders, and guiding multidisciplinary collaboration.
Pepin and Kock [5]; Kohn Radberg et al. [39]	Detail the shift of teachers to coach-like roles, fostering learning through feedback, taking a process-oriented perspective, and guiding students with different disciplinary backgrounds through challenges.

3.2. Four Dimensions of Teaching Practices in Challenge-Based Learning

In this section, the analysis is carefully structured, distinguishing the findings into four foundational educational dimensions vital to CBL: "pedagogical approaches", "technological integration", "industry and professional engagement", and "support and development". The choice of these four dimensions to organize teaching practices in the systematic review is justified by their comprehensive coverage of the key aspects of CBL and their relevance in enhancing educational outcomes in Higher Education [3,4,6,35].

Subsequently, each dimension is thoroughly discussed, providing definitions and outlining the key teaching practices discovered within each dimension, along with their descriptions and conceptual explanations. This will offer comprehensive insights into their application and significance in the educational landscape.

3.2.1. Pedagogical Approaches in CBL

The core of CBL lies in its innovative pedagogical strategies, which shift traditional teaching paradigms toward more student-centered and problem-based learning environments. This dimension is essential for understanding how CBL is implemented and how it facilitates critical thinking, problem-solving, and student engagement. According to Gyldendahl et al. [3] and Gallagher and Savage [4], CBL emphasizes experiential learning and the practical application of knowledge, which are critical for developing these skills. The term "pedagogical approaches" is used because it refers to the methods that contribute to the development of competencies in Higher Education students [49]. By focusing on pedagogical approaches, this dimension aims to identify the settings educators use to implement CBL.

The teaching practices highlighted in the Table 3 emphasize a modern pedagogical approach that places the student at the center of the learning process. Teachers transition from being traditional instructors to facilitators, guiding students through the learning journey and promoting active learning. By fostering autonomy and responsibility, these practices encourage students to take ownership of their education, which is further supported by creating collaborative learning environments. These environments not only promote teamwork and problem-solving but also ensure that students' voices are valued, creating an open space for expression and decision-making.

Table 3. Teaching practices of the "pedagogical approaches" dimension.

Teaching Practices	Description and Conceptualization
Shifting from instructor to facilitator	Teachers' roles evolve to focus on learning facilitation and support rather than direct instruction and shifting from a traditional teaching role to that of a coach or facilitator [1,5,8,32,36,44].
Facilitating the learning process	Teachers guide students through CBL, fostering autonomy in learning [45], nurturing entrepreneurial skills [6,7], and enhancing critical thinking abilities, thereby shaping proactive and dedicated community members [6,33].
Creating collaborative learning environments	Teachers enhance collaborative learning [1] by establishing positive classrooms that promote teamwork and guide problem-solving [41] while also supporting student autonomy through valuing their feelings and choices and creating an open environment for expression [36] and decision-making [42].
Promoting critical thinking and innovation	Teachers promote critical thinking and innovation [38] through holistic methodologies, enhancing the practical application of theoretical knowledge beyond the confines of the classroom [35,37] and involving students in taking action and developing innovative solutions [7,40] for sustainable development [1,39,44].
Guiding research questions and problem-solving	Educators guide students through a multifaceted process in CBL [45], where they assist in navigating complex questions and solving problems by immersing students in a mix of conceptual, procedural, and attitudinal learning [35]. This approach includes an iterative cycle [1,5] of three phases of CBL framework: "engage", "investigate", and "act" [45] and the related processes, such as analysis, diagnosis, observation, research, strategy development, decision-making, design, evaluating feasibility and environmental impact, implementation, and assessment. Consequently, it cultivates essential skills in research, analysis, and information management among students [33].
Encouraging active learning	The teacher's role encompasses empowering students to become self-directed learners [5,37] co-responsible for the creation of knowledge [34] who take ownership of their education [32,37], preparing them to master the skill of learning to learn [31] and fulfilling meaningful and lifelong learning [1] through active learning [39] or learning by doing [1].
Designing challenges	By connecting students with real-world problems observed in their communities [37], teachers create engaging [8] and motivating challenges with global importance [39,41] based on students' interests [38], integrating adaptable difficulty levels to cater to diverse abilities [36] and ensuring personalized and inclusive learning experiences [32].

These practices focus on developing critical thinking and innovation by connecting theoretical knowledge with real-world applications. Moreover, teachers are involved in guiding students through research questions and problem-solving processes, often using holistic methodologies that extend beyond the classroom. Additionally, by designing challenges that resonate with real-world issues and tailoring them to diverse student abilities, teachers can engage and motivate students, ensuring personalized and inclusive learning experiences. This comprehensive approach equips students with the essential skills needed for lifelong learning and for tackling complex global challenges.

3.2.2. Technological Integration in CBL

The evolving role of technology in education cannot be overstated, especially in the context of CBL, which often leverages digital tools to enhance learning experiences. Technological integration is vital for facilitating collaborative projects, simulating real-world problem-solving, and fostering digital literacy. As highlighted by Gaskins et al. [37] and López-Caudana et al. [6], educational technology is an essential component of effective teaching. The term "technological integration" is used because ICT adoption in Higher Education has led to gradual changes in teaching practices [50]. This dimension allows the review to assess how technology is utilized within CBL frameworks to create engaging and interactive learning environments, thereby supporting the overall effectiveness of CBL initiatives [7].

Owing to the COVID-19 pandemic, the implementation of CBL has had to be adapted to an online format, making it one of the most recent and necessary evolutions in the present. This shift to digital platforms has not only allowed CBL to continue amid global and real challenges but has also highlighted the versatility and potential of CBL to engage students in meaningful learning experiences remotely [34]. Consequently, online CBL has emerged as a critical teaching practice that must be developed further and considered. The transition to an online environment presents unique opportunities to innovate and refine CBL, ensuring that it remains an effective and engaging approach to education in a world where digital learning is becoming increasingly prevalent [43].

Considering the technological integration in CBL, teachers have focused on "using digital technology" as a key teaching practice. This has been essential not only to maintain CBL continuity but also to enhance students' digital competencies, as outlined in Table 4.

Table 4. Teaching practices of the "technological integration" dimension.

Teaching Practices	Description and Conceptualization
Using digital technology	In response to the shift from face-to-face to online delivery of CBL [43] prompted by COVID-19 [34] or the use of blended formats [1], teachers have been pivotal in incorporating technology [8] and ICTs to cultivate students' digital competencies [31–33], establishing ICT integration as an essential element of modern teaching practices in CBL [38].

The use of digital technology in education, particularly within the CBL framework, has proven essential for adapting to new teaching environments and methodologies. This technological integration has allowed for the continuation of engaging and interactive learning experiences even in the face of unprecedented global challenges. Consequently, the incorporation of ICTs into CBL has emerged as a critical practice that supports the effectiveness and relevance of education in an increasingly digital landscape. This evolution highlights the importance of continuously developing and refining teaching practices to ensure that CBL remains a dynamic and impactful learning approach.

3.2.3. Industry and Professional Engagement in CBL

This dimension underscores the importance of connecting academic learning with real-world applications, thereby reflecting the practical orientation of CBL. Collaboration with industry partners and engagement with professionals are key aspects bridging the gap between theoretical knowledge and practical skills. The term "industry and professional engagement" is used because collaboration with industry and other training institutions is suggested to improve students' employability and entrepreneurship skills [51].

According to Dieck-Assad et al. [35] and Membrillo-Hernández et al. [40], such engagement is crucial for preparing students for professional realities and for aligning education with industrial needs. This engagement can take various forms, including guest lectures from industry experts, collaborative projects, internships, and the integration of practical and industry-relevant skills and knowledge into the curriculum. By examining this dimension, this review seeks to understand how CBL initiatives can enhance students' career readiness and relevance in the job market [31]. Table 5 presents the teaching practices related to industry collaboration within the educational framework.

As shown in Table 5, educators collaborate with industry professionals to define real-world challenges and integrate professional standards and resources into students' learning. They guide students in aligning their projects with professional and ecological standards, supporting Sustainable Development Goals and enhancing employability. Additionally, teachers manage and secure resources, often collaborating with industrial partners to provide practical, hands-on learning experiences essential for students' future careers.

Table 5. Teaching practices of the "industry and professional engagement" dimension.

Teaching Practices	Description and Conceptualization
Collaborating with industry professionals	Teachers work with industry to define real-world challenges, integrating professional standards or stakeholders and resources into the learning experience [1,5,7,8,34,35,39].
Facilitating the integration of professional practices	Teachers guide students in crafting projects that comply with both professional and ecological standards, thus supporting the Sustainable Development Goals (SDGs) [7,33,35,39] and enhancing student employability [1,32].
Guiding students in managing project resources	Teachers have emerged as the pivotal resource [5], securing and utilizing both external materials and their specialized knowledge to support practical learning effectively [1,6]. By collaborating with industrial partners and leveraging their expertise in technical domains, tutors form an integral part of the instructional team that significantly enhances the practical learning experience [35].

3.2.4. Support and Development in CBL

Recognizing the need for ongoing support for both educators and students, this dimension explores the institutional frameworks that sustain CBL practices. Continuous professional development for educators and robust support structures for students are essential to the success of CBL. As noted by Campos et al. [21] and Franco et al. [36], providing educators with training in CBL methodologies and ensuring that students have access to the necessary resources are critical for achieving consistent and long-term educational outcomes.

The term "support and development" is used because learning is a complex process that requires elements that favor its expansion [52]. Support systems and development opportunities within the educational framework enhance student transitions, psychological well-being, and job training for soft skills such as leadership [52].

As shown in Table 6, the "support and development" dimension highlights essential teaching practices in which educators focus on fostering self-regulated learning and promoting autonomy, motivation, and persistence in students. Furthermore, teachers also engage in continuous professional development to effectively guide students in CBL environments, facilitate interdisciplinary communication for collaborative learning, and build student resilience through support. Likewise, teachers prepare students for future challenges by nurturing key 21st-century skills like leadership, creativity, and teamwork [7,8,45]. They involve students in decision-making and are responsible for providing constructive feedback, ensuring that learning objectives align with both academic and industry needs and shifting the focus from traditional exams to comprehensive skill development.

Table 6. Teaching practices of the "support and development" dimension.

Teaching Practices	Description and Conceptualization
Encouraging self-regulated learning	Teachers encourage students to regulate their own learning processes, fostering autonomy and self-regulated learning [5,8] and enhancing motivation [36,40] and persistence [37].
Engaging in continued professional development	Teachers undergo professional development to become facilitators and coaches in CBL environments [5,7,8,31], and additional training is useful to ensure a comprehensive understanding of CBL processes and their successful implementation [1,45].
Facilitating interdisciplinary communication	Teachers facilitate communication among students from different disciplines [41], encouraging multidisciplinary collaboration [5,6,8,31,40,41] and inter-/transdisciplinary learning [44].
Fostering resilience and providing support	Teachers aid students in overcoming challenges with supportive feedback [5] and resilience-building [40] while striving to develop their competence, fostering a sense of capability and accomplishment [36].
Preparing learners for future challenges	Teachers equip students for the demands of the real world, nurturing skills such as leadership [8,40], creativity [8,38], ethical problem-solving [31], teamwork [41], interpersonal skills [34], and entrepreneurial skills [6,7,39] to acquire 21st-century skills [7,8,45].

Table 6. *Cont.*

Teaching Practices	Description and Conceptualization
Supporting student decision-making	Teachers engage students in decision-making processes [36], though they may require further training to support internal cognitive processes [33].
Providing feedback	Teachers bear the responsibility of assessing student performance, offering structured guidance, and confirming that learning objectives are achieved [6], striking a balance between the industrial partner's needs and the competencies that students must acquire [35]. Evaluations should prioritize learning, considering the shift away from simply meeting exam criteria [37].

This dimension ensures that both students and teachers are equipped to meet the evolving demands of education and industry. By examining this dimension, this review assesses the sustainability and scalability of CBL initiatives, ensuring that they can be effectively implemented and maintained over time [53]. As a result, students benefit from guidance, resources, and feedback that fosters their growth, resilience, and self-regulation. For educators, professional development opportunities are crucial for enhancing teaching skills, particularly in adapting to innovative educational approaches such as Challenge-Based Learning, which is key to ensuring the successful implementation and long-term impact of these educational methods.

3.3. Core Teaching Practices within the Context of CBL

Figure 2 presents the core teaching practices in the CBL context. This figure systematically organizes the identified practices and offers a clear and concise overview of the fundamental approaches that define teaching for CBL. This organization not only aids in the practical application of these practices but also serves as a valuable resource for educators seeking to implement or enhance CBL methodologies in their curricula.

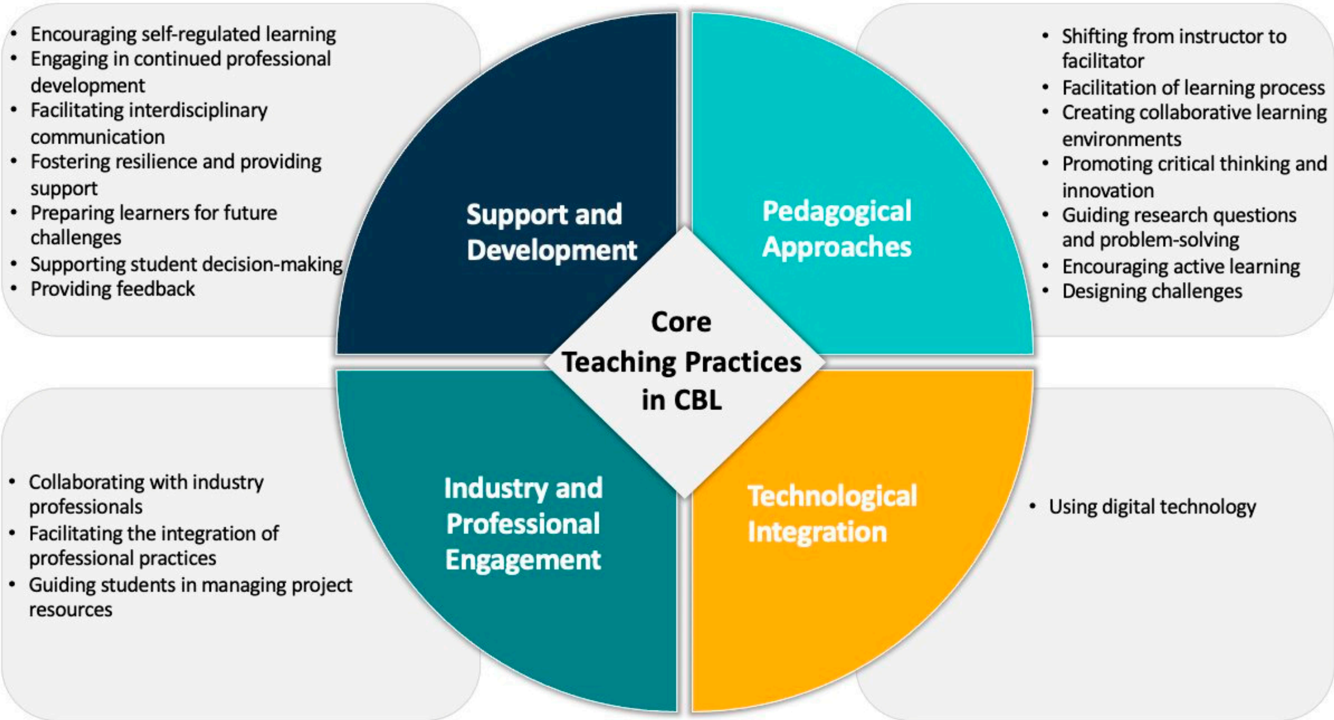

Figure 2. Core teaching practices within the context of CBL.

In the following, Figure 3 illustrates the four key dimensions and how they interconnect within the context of CBL. The schema is divided into three contexts, evolving socioeconomic, Higher Education, and industry aspects to reflect the diverse environments in which students must develop their skills and competencies. Each context offers a unique and essential perspective in shaping a comprehensive, educational experience in which teacher practices are key. The evolving socioeconomic context emphasizes the importance of preparing students to address social and economic challenges, whereas the Higher Education context focuses on academic development. Meanwhile, the industry context connects academic training with the demands and expectations of the professional world, ensuring that students are equipped to meet industry standards.

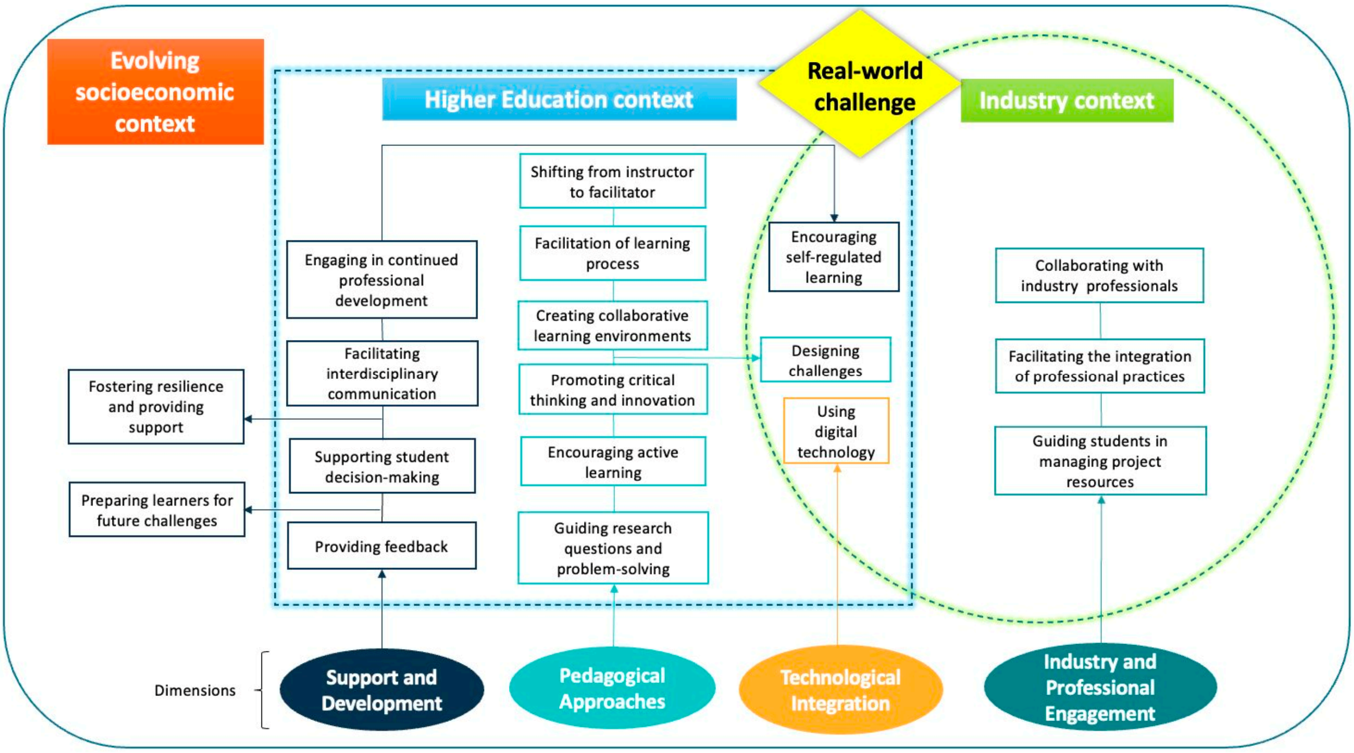

Figure 3. Interconnection of the four key dimensions within the context of CBL.

In fact, in Figure 3, Higher Education and industry contexts are interconnected, where academic knowledge is directly linked to practical applications, allowing students to translate theoretical concepts into real-world solutions. Higher Education institutions provide foundational knowledge and pedagogical strategies essential for student success, while the industrial context offers practical experience and professional standards that prepare students for the workforce.

The common element across all these contexts is the real-world challenge, which serves as the central focus guiding all teaching practices and student learning. This shared focus is crucial because the competencies developed within each context are directed toward solving real, complex problems that require an integrated, multidisciplinary approach.

Within the pedagogical approaches dimension, teaching practices are centered on creating an active and collaborative learning environment. These practices include shifting from instructor to facilitator, facilitating the learning process, creating collaborative learning environments, promoting critical thinking and innovation, guiding research questions and problem-solving, encouraging active learning, and designing challenges. These practices are designed to transform students into active, critical learners capable of exploring and solving problems creatively and innovatively.

The technological integration dimension plays a crucial role in bridging the gap between the academic context and the professional world. The practice of using digital technology supports and amplifies pedagogical strategies by facilitating connections with the digital and technological landscape, which is essential in industrial sectors. Additionally, this dimension is connected to the socioeconomic context, driven by the demands of ongoing socioeconomic changes, such as those brought about by the COVID-19 pandemic. This relationship enhances the learning experience by enabling the transition of CBL from face-to-face to online delivery, ensuring that CBL remains effective and relevant in an increasingly digital world.

In the industry and professional engagement dimension, teaching practices focus on connecting students directly with the professional environment. These include collaborating with industry professionals, facilitating the integration of professional practices, and guiding students in managing project resources. These practices ensure that students not only acquire theoretical knowledge but also develop practical, applicable skills in a real-world professional setting.

Finally, the support and development dimension involves teaching practices aimed at providing comprehensive support and fostering continuous development for both students and educators. Practices such as encouraging self-regulated learning, engaging in continued professional development, facilitating interdisciplinary communication, supporting student decision-making, providing feedback, fostering resilience and providing support, and preparing learners for future challenges focus on ensuring that students and educators are well-prepared to face educational and professional challenges.

All these practices are interconnected and do not follow a rigid sequence. Their application depends on the specific real-world challenges that students are committed to solving. This means that the pedagogical approach can vary depending on the nature of the challenge, integrating elements from all three contexts in a flexible and adaptive manner to effectively respond to real-world problems.

4. Discussion

This systematic review has focused on answering the following research question: Which teaching practices associated with Challenge-Based Learning (CBL) are identified in scientific and peer-reviewed publications in the context of Higher Education? The findings indicate that CBL significantly reshapes the educational landscape, highlighting its transformative impact on teaching and learning practices. This inquiry sheds light on prevalent teaching practices that play a pivotal role in the successful deployment of CBL across various disciplines, underscoring the dynamic and multifaceted role of educators in fostering an environment conducive to active learning and problem-solving. Consequently, this investigation reveals the critical importance of adopting educational approaches to meet the evolving needs of students and the broader educational system.

Furthermore, the significance of CBL in enhancing student learning cannot be overlooked. This approach propels students beyond the passive reception of information and encourages their active engagement with real-world problems. This approach significantly impacts the educational system by fostering critical thinking, creativity, and problem-solving skills and preparing students for the challenges of the professional world. Authors such as Abril-López et al. [31] and Dieck-Assad et al. [35] emphasize the facilitator's role as a teacher, integrating support with resources to enhance students' autonomous learning and readiness for future challenges. This emphasis on the facilitator's role bridges the gap between traditional education and the requirements of contemporary challenges, making the transition to CBL both necessary and vital for student development.

However, resistance to change presents a notable challenge for the adoption of CBL. Educators and students accustomed to traditional learning models may struggle with the shift toward a more dynamic, student-centered learning environment. This resistance can stem from a lack of understanding of CBL's benefits or fear of the unknown [1]. Although such resistances are not new, nor are they unique to the CBL [54], the literature suggests [1,45] that overcoming these barriers is essential for the evolution of teaching and learning practices in Higher Education, leading to a more engaging educational experience.

Moreover, the role of educators is paramount to the success of CBL. As highlighted by Agüero et al. [32] and Tang and Chow [45], educators transition from being the primary source of knowledge to facilitators who guide and support students' educational paths. This transformation is crucial for creating a collaborative, participatory experience that prepares students for professional demands through the integration of theory and practice in university–society collaborative learning settings [55]. This shift underscores educators' role as not just conveyors of knowledge but also as key enablers of learning and development, fostering a learning environment where students can thrive.

Additionally, understanding and applying CBL teaching practices are essential for educators' professional development. Knowledge of these practices enables educators to facilitate CBL environments more effectively and to enhance students' educational experiences. Franco et al. [36] stressed the importance of training for educators, suggesting that teaching practices are amenable to training, thereby improving the overall quality of the education delivered through CBL. This insight into the importance of educator training bridges the broader implications of CBL for student growth and adaptability.

CBL significantly contributes to student growth and supports the development of a diverse set of skills through engagement with real-world challenges. This method of learning promotes personal and professional growth and prepares students to tackle complex issues using innovative solutions. The applicability of CBL across various disciplines further illustrates its versatility and relevance to educators across all academic disciplines, from social sciences to engineering. This broad applicability highlights the transformative potential of CBL, not just in specific fields but also as a foundational approach to education across disciplines.

Lastly, the COVID-19 pandemic has catalyzed the transition from in-person to online CBL formats, introducing new challenges and opportunities for teaching and learning. This shift underscores the necessity of integrating ICTs and enhancing digital competencies for both educators and students. As society moves toward increasingly digital modes of operation, the future of online CBL looks promising, offering a more flexible, inclusive, and forward-looking approach to education. This reflection on the transition to online learning due to the pandemic situates CBL within current educational challenges and opportunities, emphasizing the need for ongoing adaptation and innovation in teaching practices.

Limitations

A significant limitation of this study is the scarcity of research specifically focusing on teaching practices in the realm of CBL. While there is a limited body of research on CBL, studies on the teaching practices associated with this innovative educational methodology are even rarer. This gap in the literature underscores the critical need for a more comprehensive investigation into how educators can effectively implement CBL in their classrooms. The lack of a detailed analysis of pedagogical strategies and approaches within CBL highlights an area ripe for future research aimed at better understanding and optimizing the role of educators in facilitating student engagement and learning in CBL environments.

Another limitation of this study is the lack of specific techniques and strategies for executing each teaching practice within the CBL framework. While this study outlines and categorizes core teaching practices, it does not delve into detailed methodologies or tactical steps for practical implementation. This gap highlights an area for future research. Subsequent studies should focus on elaborating and detailing the specific techniques that can facilitate the successful application of these identified practices. By providing a more detailed understanding of these methods, future research can contribute significantly to the refinement of CBL pedagogy, thereby enhancing the learning experiences and outcomes of students engaged in this innovative educational approach.

It is essential to emphasize the need for further exploration of the limitations of CBL and identify potential avenues for future research. By addressing these gaps, scholars can deepen their understanding of CBL and provide educators with more effective tools and strategies to successfully implement this approach. Additionally, this will enhance the overall quality and impact of CBL on Higher Education, ensuring that it remains a dynamic and valuable educational methodology.

5. Conclusions

The analysis of Challenge-Based Learning teaching practices across 20 studies within diverse disciplines underscores the critical shift needed in teaching methodologies to address the evolving educational landscape of the 21st century. This shift is articulated through the lens of CBL, in which teachers transition from traditional lecture-driven roles to roles as facilitators of a learning process that is inherently iterative, unpredictable, and immersed in solving real-life challenges without predefined solutions. As highlighted by Stavnskær [18], educators in CBL are called upon to adopt a new set of competencies that balance structured teaching with a more inclusive, activating, and improvisational approach.

This transformation underscores the teacher's pivotal role not as the primary source of knowledge but as a guide to support students in navigating the complexities of real-world problems, thereby fostering a learning environment in which students are active participants. The teacher's role evolves into that of a supervisor and communicator, engaging with students to challenge their ideas and provide feedback, thereby facilitating the innovative process from conceptualization to prototyping solutions.

This paradigm shift in teaching practices necessitates embracing uncertainty for both students and teachers. Frustration becomes an integral part of the learning process given the complexity of the challenges faced. However, this transition repositions students as equal partners in collaboratively creating, exploring, and devising innovative solutions. This not only democratizes the learning process but also enhances student motivation through managing uncertainty and doubt.

The practical implications of this study are significant, as the teaching practices outlined in Tables 3–6 and Figure 2 serve as a guide for educators seeking to implement CBL. These tables can act as a checklist to help educators align their teaching practices with the following four dimensions: pedagogical approaches, technological integration, industry and professional engagement, and support and development.

This analysis highlights the necessity for educators to evolve and embrace new roles that facilitate student-led exploration and solution development for real-world challenges. Through this comprehensive exploration, the essential interconnectedness of these themes is clarified, offering a holistic view of the vital role educators play in fostering adaptability and preparing students for future challenges within the CBL context.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/educsci14091008/s1. File S1: PRISMA Checklist; File S2: Likert teachers; File S3: Author by author teaching practices (References [1,5–8,22,31–45] are cited in the Supplmentary Materials).

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