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Context-based learning in higher education 1992-2023: trends and outstanding research areas from Scopus database

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ABSTRACT

Context-based learning (CBL) has recently gained increasing attention as a pedagogical approach in higher education to enhance students' understanding and problem-solving skills in real-world scenarios. This study aims to provide an overview of CBL-related issues in higher education as documented in publications from the Scopus database. A bibliometric analysis was employed to review 153 publications. The results show that articles on this topic have become more prevalent from 2009 to 2023, particularly in 2020 and 2022. A total of 443 authors from 160 institutions across 52 countries have contributed to research on this subject, with the USA being the most engaged nation in CBL studies in higher education, having the highest number of publications, citations, and research funding. The journal with the most publications on this topic is the International Journal of Science Education, classified in the Q1 category. Key research trends have been identified, focusing on applying CBL in engineering, software technology, teacher training, and nursing programs and its implementation in collaborative learning environments, distance learning, and online education. The findings are a critical resource for scholars interested in advancing research on CBL in higher education.

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1. INTRODUCTION

Context-based learning (CBL) is recognized as an effective approach in educational science, having been researched, tested, and applied in curricula across various countries [1]. CBL encourages educators to relate academic content to real-world scenarios, helping students connect their knowledge to its practical applications as citizens, learners, and future professionals [2]. Unlike traditional learning methods that often present knowledge in isolation, CBL integrates learning materials with authentic contexts, fostering a deeper understanding and enhancing student engagement. Real-world situations in different settings are collectively called "contexts". Abu-Rasheed *et al*. [3] build on Jong's framework of four contextual domains, emphasizing their relevance in CBL: i) The personal domain, which connects scientific knowledge to students' personal experiences, enhancing their ability to apply concepts in real-life situations; ii) The social and societal domain, which highlights the student's role in their community, addressing contemporary

societal challenges and fostering civic responsibility; iii) The professional practice domain, which links education to future career pathways, equipping students with industry-relevant skills; and iv) The scientific and technological domain, which underscores advancements in science and technology, encouraging innovation and critical thinking. According to Güth and Vorst [4], context in CBL is not merely an external setting but an integral part of the learning process, constructed through real-world situations that enhance authenticity in educational experiences.

Despite the increasing application of CBL, its implementation and effectiveness in higher education remain underexplored. While CBL has been integrated across different educational levels, its significance in higher education is particularly noteworthy, as universities aim to bridge the gap between academic knowledge and professional practice. Research on CBL has demonstrated its effectiveness in enhancing learners' understanding, improving academic performance, and developing essential skills such as problem-solving, applying knowledge to real-world situations, higher-order thinking, and reasoning skills [5]. In higher education, these competencies are essential for producing graduates who are well-equipped for the evolving demands of the workforce, making the adoption of CBL a strategic priority for universities worldwide. Studies on CBL in higher education reveal that it helps students meet the learning outcomes required by their academic programs and acquire the necessary competencies for future careers [6], [7].

The integration of CBL in university curricula allows students to engage in experiential learning, where theoretical knowledge is continuously applied to solve practical challenges. Chashko [8] used the Academic Model United Nations to model real-life professional scenarios for students, promoting the development of intercultural communication, personal autonomy, and professional skills. Farzi *et al.* [9] engaged nursing students in discussions on real-life scenarios and experiential learning to enhance their understanding of professional behavior and the actual work environment. The simulation of real-world aircraft design processes enables students to think like professionals without being constrained by academic solutions [10]. These examples highlight the effectiveness of CBL in preparing students for real-world professions by fostering problem-solving abilities, adaptability, and domain-specific expertise. Thus, CBL is a suitable approach in higher education, helping students acquire the knowledge and skills needed for future jobs. However, while numerous case studies on CBL implementation exist, a comprehensive, systematic, and data-driven evaluation of its research trends in higher education remains lacking.

To date, no prior study has holistically analyzed CBL research from a bibliometric perspective, mapping its evolution, key themes, and research gaps over time. This underscores the importance of systematically investigating its applications to optimize its impact on student learning and employability. Many authors have conducted research on CBL in higher education on topics such as the role and challenges of CBL [11], specialized teacher guidance [12], and context development for implementing CBL [13]. Comprehensive reviews of CBL in educational science using bibliometric methods and Scopus and WoS databases have been conducted by Morales [14] and Kan and Kumas [15]. In higher education, some authors have reviewed specific roles of CBL [16] or examined studies within a particular discipline [11]. Nevertheless, existing reviews remain fragmented, often focusing on specific disciplines or adopting limited methodological scopes. This study addresses a critical gap by conducting a systematic, large-scale bibliometric analysis of CBL research in higher education, identifying key trends, influential authors, leading institutions, and thematic developments over the past three decades.

A systematic evaluation of the development, trends, and research directions of CBL in higher education is necessary to provide a comprehensive perspective and guide future investigations. This study has both theoretical and practical significance. First, an in-depth review of CBL research trends from 1992 to 2023 will clarify its evolution, identify key thematic areas, and highlight gaps requiring further exploration. Identifying these trends will support the effective integration of CBL into university curricula, thereby improving education quality and enhancing students' job readiness. On a global scale, higher education institutions face increasing pressure to reform curricula to align with workforce demands. CBL facilitates this transformation by promoting experiential learning, critical thinking, and problem-solving skills. In developing countries, where traditional lecture-based methods still dominate, understanding how CBL can be effectively implemented could provide valuable insights for curriculum innovation. At the local level, studying CBL in higher education is crucial for enhancing student employability and ensuring graduates can adapt to labor market shifts. Unlike primary and secondary education, which focus on foundational knowledge, higher education must prepare students for real-world professional challenges. Therefore, researching CBL in higher education is particularly relevant, as it supports competency-based education, bridges the skills gap, and strengthens career readiness.

To the best of our knowledge, this study is the first to conduct a systematic bibliometric analysis of CBL research in higher education, examining publication trends, influential contributions, and thematic evolution from 1992 to 2023. Unlike prior reviews that primarily focus on case studies or specific disciplines, this study offers a macro-level perspective on CBL research through data-driven bibliometric techniques.

By analyzing Scopus-indexed publications, this study used bibliometric analysis to answer the following research questions:

i) What is the total number of publications, growth rate, and overall trends in CBL research in higher education?
ii) Which countries and institutions have significantly contributed to CBL research in higher education?
iii) Who are the most prolific authors on this topic?
iv) Which sources have the highest number of publications?
v) What insights are provided by the most-cited publications on CBL in higher education?
vi) What are the themes and research trends in CBL in higher education based on title, abstract, and keyword analysis?
vii) Which subject areas have the highest publications on CBL in higher education?

2. METHOD

In this study, bibliometric analysis was employed to analyze data. This method collects quantitative information on publications and citations [17], and it is widely used to track scientific developments across different fields [18]. The data collected using this method is highly beneficial for researchers seeking to identify future research directions [3]. The data was extracted from Scopus, the largest and most widely used scientific database for the social sciences [19], [20]. This database organizes data by research fields, which is convenient for searching and bibliometric analysis. The data collection process is carried out through the preferred reporting items for systematic reviews and meta-analyses (PRISMA) diagram, as seen in Figure 1.

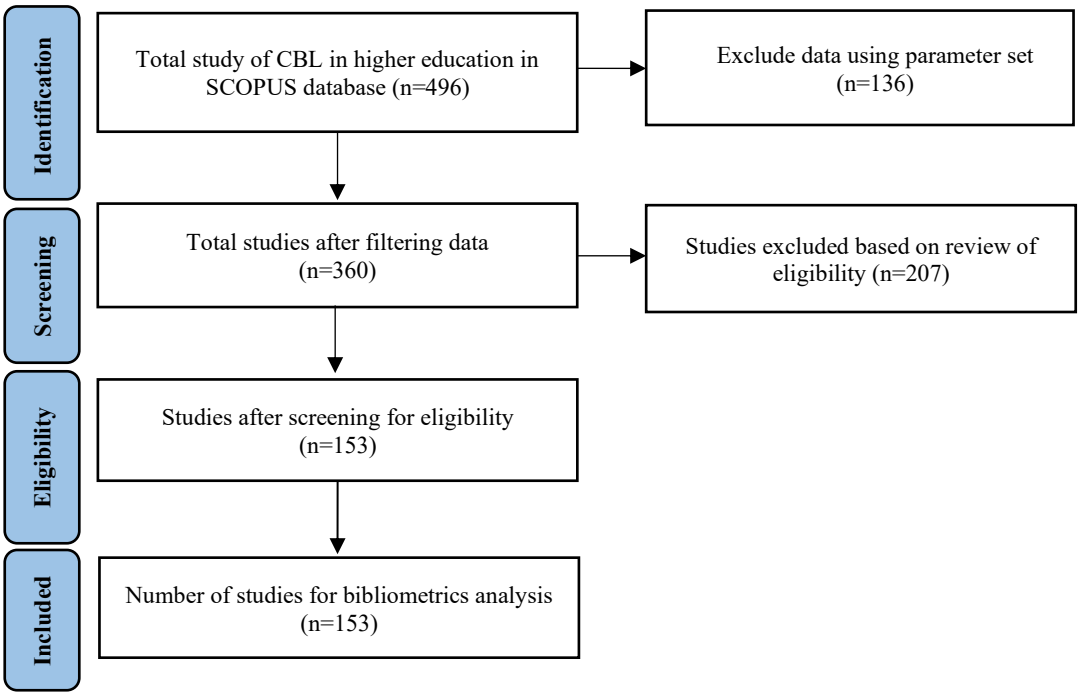

Figure 1. The PRISMA diagram represents narrowing the analysis dataset of applying CBL in higher education

The first is identification. The central keyword of this study is “context based learning”. Some related and close keywords are also used. These keywords are combined with the keyword of the level of education that the study is targeting higher education. These keywords are searched in the document’s abstract, keywords, and title. The document type is limited to scientific publications and conference papers written in English published before 2024. The results obtained 496 documents (data collected on April 6, 2024) when perform the data query string through Scopus. Step 2 is screening. This step involved filtering to select publications that align with the research objectives. In the initial filtering phase, the research team excluded 136 publications due to inaccurate or incomplete information. At the end of this phase, 360 publications were retained and moved to the next step. Thirdly is eligibility. An additional 207 publications

were excluded at this stage. The reasons for elimination included publications where the context referred to geographical scope, contexts used for developing algorithms or software, contexts involving cultural or social issues, contexts addressing specific professional problems that were not utilized in teaching activities, and publications on CBL conducted with K-12 students. The last is inclusion. The research team refined the list to 153 publications suitable for bibliometric analysis. These publications met the eligibility criteria by satisfying the content requirements related to the research topic.

Using the list obtained after data collection, initial analyses were performed using tools provided by Scopus to gather additional information about authors, affiliations, and journals. The authors exported information from the search results into CSV files (.csv extension) and Bibtex files (.bib extension) for more in-depth analysis. Two tools were selected for data analysis: Bibliometrix and VOSviewer software. Additionally, Microsoft Excel was utilized to aggregate data by country and period.

3. RESULTS AND DISCUSSION

3.1. General information and publication trends

General information about the collected dataset on CBL in higher education is presented in Table 1. From 1992 to 2023, 153 publications including 106 articles (accounting for 69.3%) and 47 conference papers (accounting for 30.7%), were issued from 126 different sources, utilizing 5,819 references. The annual growth rate of publications is 7.71%, and the average document age is 7.65 years. The 443 authors contributed to the dataset, including 20 authors of single-authored documents. The remaining authors collaborated, with an average of 2.99 authors per publication and an international collaboration rate of 12.42%.

The H-index of the dataset extracted from Scopus is 19, which means that out of 153 publications, 19 publications are cited at least 19 times. According to the calculation results, the total cumulative citations of the 153 publications are 1,538, so the average number of citations per publication is 10.5. The growth trend in the number of publications and the annual cumulative citations from 1992 to 2023 is shown in Figure 2.

The bibliometric analysis of CBL in educational science was conducted by Fayzullina *et al*. [21] using the Scopus database and Kan and Kumas [15] using the WoS database. However, this study is the first to focus on higher education within the Scopus database. According to the data presented in Figure 2, publications on CBL in higher education began appearing in the Scopus database between 1992 and 2008. However, the number of studies during this period was minimal, with only one or two publications each year. The first publication emerged in 1992, but it was not until 1997 that the second publication appeared. During this phase, a total of 11 publications were released. The year 2009 marked a shift, with five publications signaling the beginning of a steady increase compared to the previous period. Over the next seven years, from 2010 to 2017, there was notable growth in the number of publications. A total of 61 publications were released during this period, with the number of annual publications ranging from zero to six. The period from 2018 to 2023 saw the highest number of publications, with 74 articles (accounting for 48.4% of all publications during the entire study period). However, the growth pattern was inconsistent. While the lowest number of publications occurred in 2019, with only six articles, 2020 and 2022 recorded significantly higher numbers, with 19 and 20 publications, respectively.

Table 1. Main information about the data

Description	Results
Timespan	1992:2023
Sources (journals, books)	126
Documents	153
Annual growth rate (%)	7.71
Document average age	7.65
Average citations per doc	9.562
References	5,819
Document contents	
Keywords plus	642
Author's keywords	541
Authors	443
Authors of single-authored docs	20
Authors collaboration	
Single-authored docs	20
Co-authors per doc	2.99
International co-authorships (%)	12.42
Document types	
Article	106
Conference paper	47

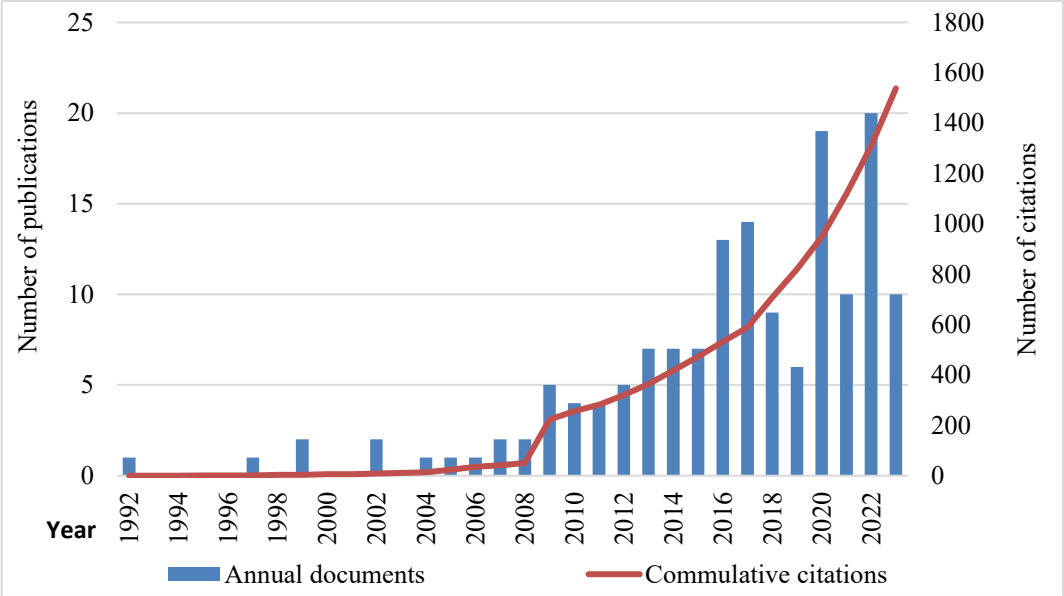

Figure 2. The cumulative annual number of publications and citations of CBL studies

This is mainly due to the powerful influence of globalization, which has emphasized the urgency of foreign language proficiency and intercultural communication skills as essential for students to integrate into multicultural societies [22]. Additionally, the COVID-19 pandemic spurred research on using software and online tools in education [23], [24]. As a result, most studies in 2020 and 2022 focused on using multicultural contexts to teach foreign languages and employing software and online tools to create learning contexts [25]–[27].

3.2. Contributions by country

A country's contribution to a research topic can provide valuable insights into its level of interest, scientific capacity, and research policies or strategies. In this case, the contributions of various countries to CBL in higher education were analyzed by examining the number of publications, citation counts, and details of funded research. According to the collected dataset, 52 countries have contributed to publications on CBL in higher education. The top seven countries with the highest number of publications are listed in Table 2. The USA leads the list with 15 publications (representing 9.8% of all publications) and has the highest total number of citations, with 256 (accounting for 16.6% of all citations). The UK and China follow with 10 and 8 publications, respectively. While the UK ranks second in total citations (11.1%), China only accounts for 4.5%, partly because China's contributions began in 2020. The remaining four countries each published between 5 and 7 papers. Although fifth in the number of publications, Australia ranks third in citations with 107, mainly due to the contribution of Dang *et al.* [28], which received 67 citations. The Netherlands ranks last in the number of publications and citations among the top seven countries. In this study, we use some abbreviations: TP is total publications, TC is total citations, TC/TP is citation per paper, SCP is single country publications, MCP is multiple country publications, PY is publication year, CP is conference proceeding, and JN is journal.

Table 2. Information on the top seven countries with the highest number of publications on the topic of CBL in higher education

Rank	Country/territory	TP	%	TC	%	TC/TP	SCP	MCP
1	USA	15	9.8	256	16.6	17.1	13	2
2	UK	10	6.5	170	11.1	17.0	7	3
3	China	8	5.2	69	4.5	8.6	8	0
4	Spain	7	4.6	73	4.7	10.4	7	0
5	Australia	6	3.9	107	7.0	17.8	5	1
6	Turkey	5	3.3	62	4.0	12.4	5	0
7	Netherlands	5	3.3	45	2.9	9.0	5	0

The average number of citations per publication (TC/TP) varies among these countries. Despite having fewer publications than the top two countries, Australia has the highest TC/TP at 17.8. By comparison, the USA and the UK, which have three and twice as many publications as Australia, rank second and third in this category. This discrepancy is partly due to Australia only starting to publish on CBL in higher education in 2013, whereas the USA's first publications appeared in 2002 and the UK's in 1999. Among the publications from the top seven countries, six involved international collaborations, particularly between authors from the USA, UK, and Australia. The remaining publications were published by authors from the same country.

To explore the USA's dominance in publication output, the authors investigated the sources of funding for CBL research in various countries. According to the data collected, 48 out of the 153 publications on CBL in higher education were funded by 37 organizations. These organizations come from 17 countries and one European Union funding organization. The top five organizations with the highest number of funded projects are shown in Table 3.

Table 3. Top five funding organizations

Rank	Funding sponsor	Country	Numbers
1	National Science Foundation	USA	8
2	Euskal Herriko Unibertsitatea	Spain	2
3	Universidad de Valladolid	Spain	2
4	National Office for Philosophy and Social Sciences	China	2
5	Monash University	Australia	2

As shown in Table 3, the National Science Foundation (NSF) from the USA tops the list with eight funded projects. The other organizations in the top five each funded two projects. Two Spanish universities jointly funded three publications, including "Implementing citizen science programmes in the context of university gardens to promote teachers' scientific literacy: a study case on soil," funded by both institutions. Two recent publications from China (2020 and 2022) were funded by the National Office for Philosophy and Social Sciences. Finally, Monash University in Australia funded two publications. Interestingly, 8 out of 15 publications from the USA (53.3%) were funded by the NSF, making it a significant contributor to CBL research. The NSF was also the second-largest funder of CBL research in educational science as of 2022 [21]. As can be seen, the NSF is one of the organizations that has a vital role in providing scientific publications on CBL topics, especially CBL in higher education in the United States.

3.3. Contributions by institutions and authors

According to the data collected, authors contributing to research on CBL in higher education come from 160 institutions across 52 countries. The number of authors contributing varies among these institutions. The top nine institutions with the highest number of authors are presented in Table 4.

Table 4. Top nine institution with many authors participating in publication

Rank	Institution	Country	Authors	Articles	Total citations
1	Ural State University of Economics	USA	7	2	5
2	Tra Vinh University	Vietnam	7	1	0
3	Norwegian University of Science and Technology	Norway	6	3	7
4	Pennsylvania State University	USA	6	1	20
5	University of Nebraska	USA	6	1	6
6	Bradley University	USA	5	1	29
7	Lorestan University of Medical Sciences	Iran	5	1	4
8	Princess Nourah Bin Abdulrahman University	Saudi Arabia	5	1	15
9	School of Chemistry	Australia	5	2	21

According to the statistics, the most significant contributor by country is the USA, with 24 authors from 4 institutions; the remaining countries have one institution. Regarding the number of authors, the top nine institutions are two: Ural State University of Economics, with seven authors participating in two publications; Tra Vinh University, with seven authors participating in one publication. Next are three institutions: Norwegian University of Science and Technology, with six authors participating in three publications; Pennsylvania State University and University of Nebraska, with six authors participating in one publication. The last are four institutions, with five authors participating in one to two publications. The total number of citations varies between institutions. The representative of Vietnam is Tra Vinh University, and although it is at the top in the number of participating authors, this publication has not had any citations.

Meanwhile, Bradley University is in the group with the fewest authors in the top nine but has the highest number of citations. In terms of publications, based on Scopus data, three affiliations have published three articles, 22 affiliations have published two articles, and 135 affiliations have published one article each. The affiliations with the highest number of publications are detailed in Table 5.

According to the statistics, the University of Warwick has the highest number of citations with 27, the Norwegian University of Science and Technology with seven, and finally, the University of California, Berkeley, with 5. Thus, the publications and citations are not concentrated in each affiliation but are scattered across different affiliations. Most affiliations only have one publication. About contribution by authors, according to the data presented in Table 1, 443 authors have published on the topic of CBL in higher education. The top eight authors with the highest number of publications are listed in Table 6. The PY(TC) column was added to show the number of citations for each publication.

Table 6 shows that the publication period for these top eight authors spans from 2009 to 2023, with most authors publishing within a short timeframe (less than four years) before halting further publications. The author with the most publications is Joy, with three publications and 27 citations. The remaining authors have each published two articles. The highest citation count belongs to a publication co-authored by Antonczak and Cochrane in 2016, with 21 citations. Eugenio-Gozalbo's 2020 publication ranks second with 15 citations. Li from Zhejiang Normal University, China, represents Asia. Li has published two papers, with the 2020 paper receiving 10 citations, while the 2023 paper has not yet been cited. The other authors' publications have received between 4 and 11 citations.

Contributions by institutions and authors indicate that research on CBL in higher education remains dispersed and has not yet been concentrated within a specific group of institutions, despite the involvement of many authors. The number of highly influential authors remains limited, and their research engagement tends to be short-term. This suggests that to create a greater impact in this field, increased attention from researchers is needed to foster collaboration, conduct in-depth studies, and ensure sustained participation.

Table 5. Top three affiliations with the most publications

Rank	Affiliation	Country	TP	TC
1	University of Warwick	UK	3	27
2	Norwegian University of Science and Technology	Norway	3	7
3	University of California, Berkeley	USA	3	5

Table 6. Top eight authors with the most publications on CBL in higher education

Rank	Author	Institution/Country	PY(TC)	TP	TC	TC/TP
1	Joy, M.	The University of Warwick, UK	2009 (9), 2009 (7), 2010 (11)	3	27	9.0
2	Abedin, B.	Queensland University of Technology, Austra	2015 (4), 2015 (4)	2	8	4.0
3	Antonczak, L.	University of Strasbourg, France	2014 (9), 2016 (21)	2	30	15.0
4	Cochrane, T.	University of Melbourne, Australia	2014 (9), 2016 (21)	2	30	15.0
5	Eugenio-Gozalbo, M.	University of Valladolid, Spain	2020 (15), 2022 (4)	2	19	9.5
6	Kävrestad, J.	University of Skövde, Sweden	2019 (7), 2020 (6)	2	13	6.5
7	Nohlberg, M.	University of Skövde, Sweden	2019 (7), 2020 (6)	2	13	6.5
8	Li, Y.	Zhejiang Normal University, China	2020 (10), 2023 (0)	2	10	8.0

3.4. Journals publishing CBL research

The 126 sources have published articles on CBL in higher education. The top six sources with the highest number of publications are described in Table 7. According to data from Scimago Journal and Country Rank on May 16th, 2024.

Table 7. Top six journals with the most publications on CBL in higher education

Rank	Source	Type	TP	TC	TC/TP	Scopus quartile 2023	Cite Score 2023
1	International Journal of Science Education (IJSE)	JN	8	205	25.63	Q1	4.6
2	Journal of Chemical Education (JCE)	JN	4	101	25.25	Q2	5.6
3	Chemistry Education Research and Practice (CERP)	JN	3	98	32.67	Q1	4.8
4	Eurasia Journal of Mathematics, Science and Technology Education (EJMSTE)	JN	3	61	20.33	Q2	4.3
5	Journal of Physics: Conference Series (JPCS)	CP	3	3	1.00	-	1.2
6	Proceedings - Frontiers in Education Conference (FIE)	CP	3	7	2.33	-	1.2

According to the data, the top four journals publishing the most papers on CBL are all classified in Q1 and Q2. The IJSE has the highest number of publications and citations, averaging 25.63 citations per publication. Ranking second is the JCE, with four publications and an average of 25.25 citations per article. In third place is CERP, with three publications and the highest average citation rate per article at 32.67. However, most of the citations for CERP come from a single article by Vaino *et al*. [29], which has 71 citations. The fourth-ranked journal is the EJMSTE, with an average of 20.33 citations per article. Ranking fifth and sixth are two CP that have garnered only three and seven citations for three publications. This indicates that the published research is of high quality and that the topic of CBL in higher education is attracting substantial attention.

The CiteScore is a journal impact metric that reflects the average annual number of citations for recent articles published in that journal [30]. According to the statistics, the journal with the highest CiteScore among the top six is JCE, followed by CERP, IJSE, and EJMSTE. Journals tend to have significantly higher CiteScore compared to CP. This is because CP are not as widely accessed as journals, and researchers generally prioritize journals due to their higher research weight than CP in many fields [31].

3.5. Information about the publications with the highest number of citations

General information about the top 10 most-cited publications is presented in Table 8. These publications, released between 1999 and 2017, have received between 33 and 73 citations and are categorized into five groups. The highest-cited group includes two publications. The first is by Bennett *et al.* [32], with 73 citations, focusing on teachers' experiences implementing context-based chemistry teaching. The second is by Vaino *et al*. [29], with 71 citations, investigating the role of CBL in motivating students in chemistry education. The second group, with citation counts ranging from 65 to 67, includes three publications by Dang *et al*. [28], Mahaffy *et al*. [33], and Barker and Millar [34]. These publications cover three main topics: designing learning materials in context-based chemistry teaching, exploring student thought processes about basic chemistry concepts after a long-term context-based chemistry course, and the impact of social context on teaching practices. Notably, four of the five highest-cited papers are related to chemistry education, one of the earliest disciplines to apply CBL in university teaching [35].

Table 8. Top ten most-cited publications

Rank	Document title	Journal title	TC	TC/year	IEEE citation
1	Context-based and conventional approaches to teaching chemistry: Comparing teachers' views	International Journal of Science Education	73	4.06	[32]
2	Stimulating students' intrinsic motivation for learning chemistry through the use of CBL modules	Chemistry Education Research and Practice	71	6.45	[29]
3	Beyond "inert" Ideas to Teaching General Chemistry from Rich Contexts: Visualizing the Chemistry of Climate Change (VC3)	Journal of Chemical Education	67	11.17	[33]
4	The impacts of globalisation on EFL teacher education through English as a medium of instruction: An example from Vietnam	Current Issues in Language Planning	67	6.70	[28]
5	Students' reasoning about chemical reactions: What changes occur during a context-based post-16 chemistry course?	International Journal of Science Education	65	2.71	[34]
6	A review and critique of context-based physics instruction and assessment	Educational Research Review	54	3.60	[36]
7	Problem-based learning in an introductory computer-engineering course	Proceedings - Frontiers in Education Conference	42	2.00	[37]
8	Factors affecting students' continued usage intention toward business simulation games: An empirical study	Journal of Educational Computing Research	38	4.75	[38]
9	A comparison of different teaching designs of 'acids and bases' subject	Eurasia Journal of Mathematics, Science and Technology Education	32	4.57	[39]
10	Assessing CBL: Not only rigorous but also relevant	Assessment and Evaluation in Higher Education	33	2.20	[7]

The third group, represented by Taasoobshirazi and Carr [36], has 54 citations. This paper is a critical and evaluative study of contextualized physics teaching. The study presents the existing problems in traditional physics teaching methods, then describes and analyzes in-depth ten publications that implement contextualized physics teaching to examine students' motivation, problem-solving, or achievement. The authors recommend further well-designed CBL research to enhance its effectiveness in physics teaching. The fourth group includes publications by Striegel and Rover [37], Liao *et al*. [38], and Ültay and Çalik [39], all discussing the role of specific contexts used in CBL, such as integrated classroom/laboratory environments,

business simulation games, and the 5Es learning model. The last paper in the top 10 is by Williams [7], the only one focused on assessment in CBL, which proposes the development of technology-supported tools and techniques for assessment. When considering the average number of citations per year (TC/year), the rankings within the top ten change. Based on this metric, Mahaffy *et al*. [33] ranks first with 11.17 TC/year, followed by Dang *et al*. [28] with 6.7 TC/year, and Vaino *et al*. [29] with 6.45 TC/year. The remaining publications have fewer than 5 TC/year.

3.6. Keyword analysis

The keyword analysis was conducted using the Biblioshiny and VOSviewer. To obtain accurate statistical results, we used a thesaurus file in VOSviewer to merge synonymous keywords, abbreviations, and singular/plural forms. The co-occurrence network of the 57 most common keywords, which appear together in at least three publications, is presented in Figure 3. Based on the network diagram, four main clusters of keywords can be identified, represented by different colors: yellow, green, red, and blue.

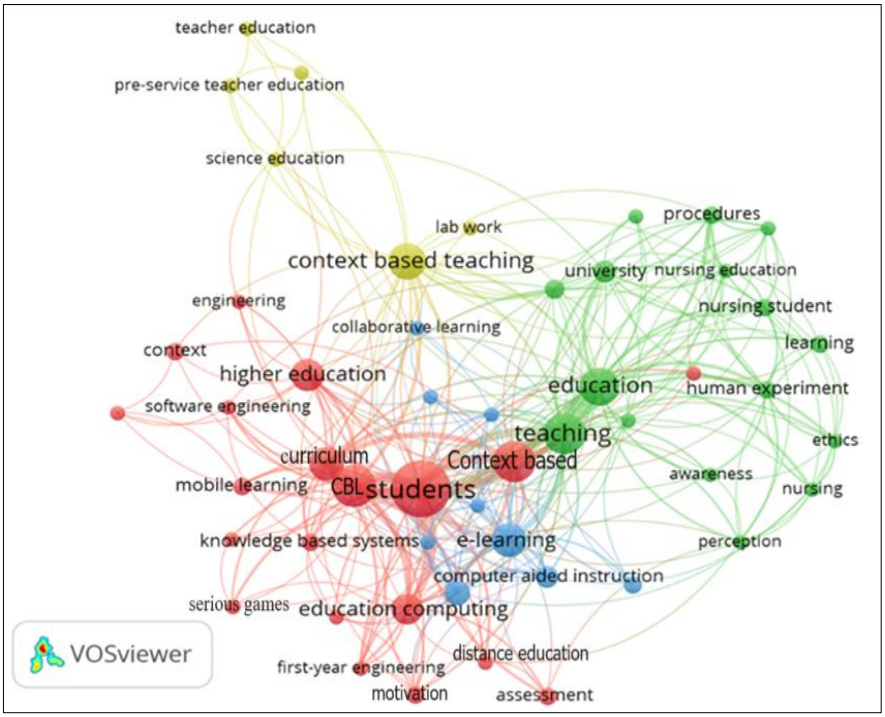

Figure 3. Keyword co-occurrence network of the 57 most common keywords, appearing together in at least three publications

3.6.1. Yellow cluster

This group includes keywords such as "teacher education," "pre-service teacher education," "science education," "lab work," and "context-based teaching." These articles focus on using CBL in training pre-service teachers and on teachers' perspectives when implementing CBL. Teachers believe that using CBL increases student motivation, achievement, and engagement while also helping to enhance their context-based teaching skills [40]. Teachers have noted that context-based teaching requires not only scientific knowledge but also real-world contextual knowledge. Therefore, they need professional support and a teaching environment that aligns with the proposed context [41]. Many authors incorporate everyday life contexts, social science issues, and professional realities during pre-service teacher training. For example, Blanco-Figueredo and Arias-Ortega [42] suggest that developing intercultural critical thinking, autonomy in seeking intercultural knowledge, and intercultural communication should be included in education science curricula. Schulze and Kanwischer [43] experiment demonstrated that implementing CBL through community service learning projects enhances students' pedagogical knowledge and skills while promoting positive changes in their awareness and perspectives on social issues. Additionally, context-based tests were appreciated by both teachers and students, as they believed this method drew more student attention [44].

3.6.2. Green cluster

This group includes keywords like "nursing education," "nursing student," "perception," "problem-based learning," "psychology," and "student-centered learning." These articles discuss the use of virtual reality (VR) and online tools in CBL for nursing students. VR simulates how virtual parents emotionally respond to pediatric nursing interventions, helping students better handle the emotional reactions of patients' families [45]. Online tools such as Google Classroom and Google Meet enhance student collaborative learning [25], while Microsoft Teams is utilized for online assessments [23]. Research also focuses on changes in students' attitudes and perceptions when using CBL. Shayestehfard *et al*. [46] developed an educational framework to teach ethical sensitivity, encompassing purpose, content, and learning methods based on moral perception, emotion, critical thinking, and collaboration findings. Sumter and Owens [47] used health and biology models to teach chemical concepts, increasing student interest in chemistry and bridging the cognitive gap between biology and chemistry.

3.6.3. Red cluster

This cluster contains keywords such as "technology," "software engineering," "serious games," "professional aspects," "motivation," "mobile learning," "learning systems," "knowledge-based system," "engineering education," and "curriculum." This cluster includes articles that address the use of VR and online tools in CBL for nursing students. In particular, the construction of context through technology, educational games, and the creation of mobile learning tools suitable for students' learning styles, levels, and locations are interesting. Cybersecurity games used by Gáliková *et al*. [48] help students improve their security awareness and cybersecurity skills. Yamaguchi *et al*. [49] employed a mobile vocabulary meter to help students learn new vocabulary in context, aiding retention when the words appeared in sentences. Two publications by Yau and Joy published in 2009 and 2010 proposed a tool to retrieve context-related information based on location, time, and factors related to learning style, knowledge level, focus, and interruption frequency, providing appropriate learning materials for students.

3.6.4. Blue cluster

This group includes keywords like "academic writing," "assessment," "collaborative learning," "computer-aided instruction," "distance education," "e-learning," and "social network." These articles explore using computer-assisted learning and social networks to create contexts for applying CBL in collaborative, distance, and online learning environments. Using CBL in virtual learning environments fosters critical thinking in students [50] while incorporating social networks into context design enhances student engagement and learning experiences [51]. Video lectures distributed as open educational resources on platforms like YouTube or through immersive experiences like Dreams of Dali have also been used to create new learning experiences that increase student interest and participation in lessons [52], [53].

To further clarify the research directions related to CBL in higher education, the authors conducted an analysis of author keywords for the period 2018–2023, as seen in Figure 4. To ensure the accuracy of the results, keywords that did not directly reflect research directions but were merely related to the research subjects were excluded. The analysis results indicate that "context-based learning" is the most frequently occurring keyword. Additionally, keywords such as "blended learning," "teacher education," "e-learning," "learning system," and "context-based teaching" were prevalent during 2019–2021, reflecting key research trends in that period. Meanwhile, emerging keywords in recent years include "big data predictive analysis," "academic staff competencies," and "agency," suggesting an expansion of CBL research into areas related to big data analysis, faculty competency development, and learner agency.

The comparison between the trend topics chart and the research clusters by color indicates that CBL is not confined to a fixed research direction but is instead differentiated based on target groups and research objectives. The presence of terms such as "teacher education," "context-based teaching," and "empirical study" reflects significant interest in applying CBL in teacher training, aligning with the yellow cluster. Studies within this cluster emphasize that CBL not only enhances student motivation and performance but also helps teachers develop context-based teaching skills. Therefore, for effective CBL implementation, educators need professional support and a conducive teaching environment. Additionally, the appearance of keywords like "e-learning," "learning system," and "distance learning" highlights the growing interest in integrating CBL into digital education platforms, corresponding to the blue cluster. Research in this cluster focuses on online learning, distance education, and intelligent learning support systems.

The application of CBL in digital environments not only fosters critical thinking and student engagement but also expands opportunities for personalized learning through learning management systems and open educational resources. Furthermore, the keywords "software security" and "blended learning" are associated with the red cluster, which explores the integration of CBL with technology to create flexible learning environments. This aligns with the current trend of leveraging online learning systems, software security, and mobile technologies to personalize learning experiences. The emergence of new keywords such

as “big data predictive analysis,” “academic staff competencies,” and “agency” reflects the increasing interest in applying big data analytics and artificial intelligence (AI) in education. At the same time, it underscores the role of faculty competencies and learner agency in innovating teaching methodologies, aligning with the green cluster. Research in this cluster focuses on VR and online platforms, aiming to enhance educational effectiveness and develop student-centered learning models.

According to Fayzullina *et al*. [21], research on CBL in educational sciences primarily focuses on the role and impact of CBL on learning outcomes, curriculum design models, and professional development strategies for teachers. Meanwhile, Kan and Kumas [15] in their study using the WoS database, emphasize the application of CBL in physics, chemistry, biology, and online learning environments. This highlights that the role of CBL and the design of learning contexts are two central areas of focus in educational research. However, research in higher education tends to emphasize context design through software, online tools, VR, and mobile devices, whereas educational sciences place greater emphasis on teacher professional development. These findings not only reflect the evolution of CBL research but also illustrate the broader trend of educational innovation in recent years. These research directions not only optimize the teaching process but also expand opportunities for enhancing learning experiences in a more practical and flexible manner. Notably, the application of CBL in developing new teaching models, integrating digital technology, and leveraging data analytics is expected to become a prominent research direction in the future, contributing to the advancement of higher education quality.

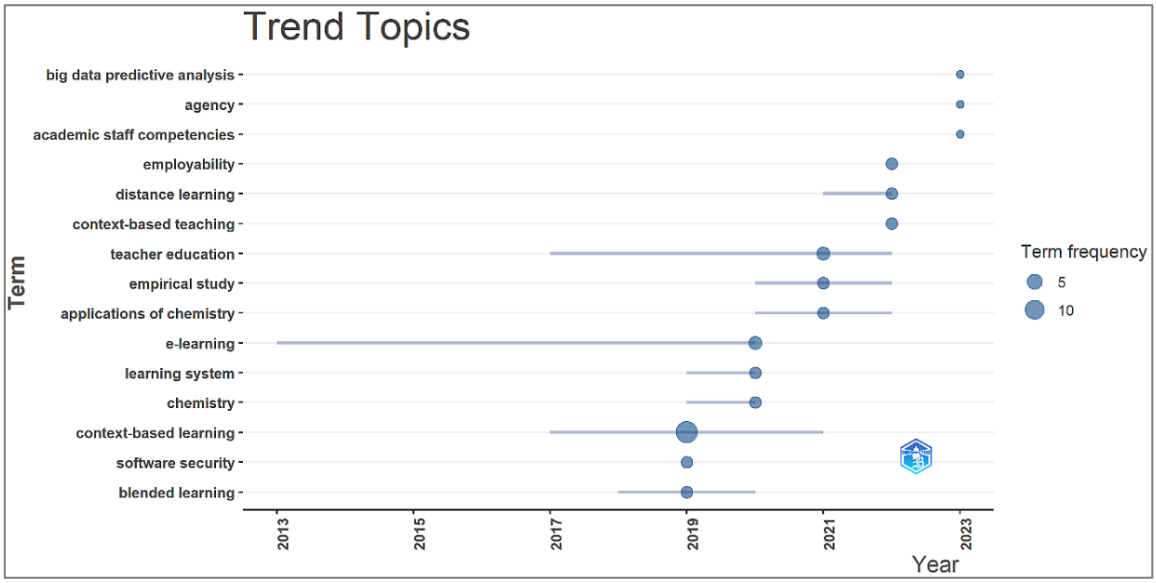

Figure 4. Trend topics of publication collection on authors’ keywords, period 2018–2023

3.7. Subject area

Based on the data collected, publications on CBL in higher education span 20 different subject areas. The most frequently represented subject areas are shown in Figure 5. The statistical results show that the most published publications belong to social sciences, with 41.2% of publications in this subject area. The following two positions are computer science with 17.2% and engineering with 9.9%. This is one of the main research trends identified through the keyword network analysis. The following three subjects with nearly equivalent product regulations are business, management and accounting, chemistry, and arts and humanities.

This result aligns with the findings of Fayzullina *et al*. [21] on CBL in science education using the Scopus database, which reported that 75% of publications belong to the field of social sciences, followed by 10% in computer science, 9% in chemistry, and 6% in engineering. Meanwhile, the research results of Kan and Kumas [15], based on the WoS database on the topic of CBL in educational science, indicate that 50% of the published studies are in the field of natural sciences, followed by 7% in engineering and 6% in medicine and health. These results highlight a distinct difference in research trends between the Scopus and WoS databases. While the majority of studies indexed in Scopus belong to the field of social sciences, WoS exhibits a greater focus on natural sciences. This disparity can be attributed to the differing applications of

CBL across disciplines. In social sciences, CBL is primarily employed to foster critical thinking, address real-world issues, and enhance soft skills in education. In contrast, within the domains of Natural sciences and engineering, CBL studies are predominantly associated with experiential learning, laboratory research, and technological applications. Furthermore, this divergence also reflects the structure of data organization and the research priorities of each database. Scopus has a strong emphasis on Social Science research, whereas WoS is more oriented toward natural sciences and applied disciplines.

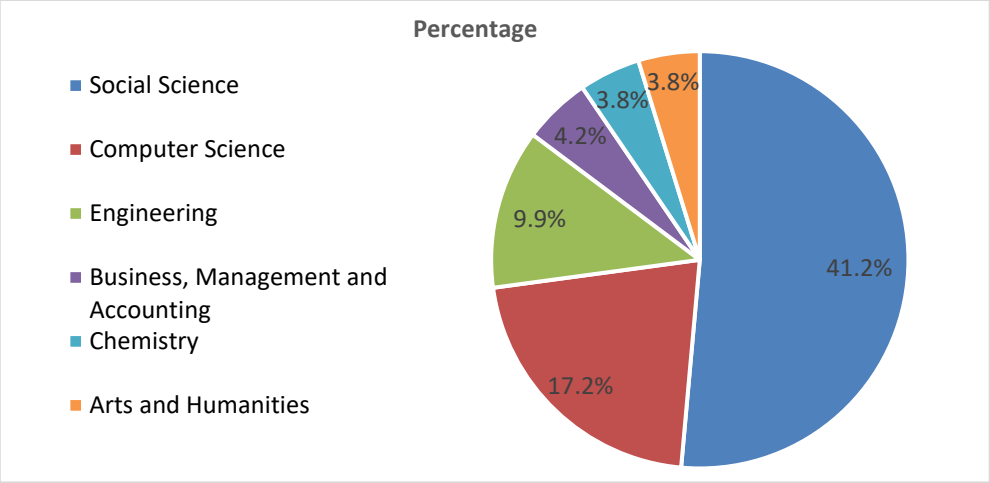

Figure 5. Subject areas with the most publications

4. CONCLUSION

This study, conducted through bibliometric analysis using the Scopus database, provides a comprehensive overview of research CBL in higher education from 1992 to 2023. The results reveal that the majority of publications emerged during the period 2018–2023, with a notable trend in the use of multicultural contexts and technology-assisted tools in CBL. The USA leads in terms of publication volume, citations, funding, and participation of authors and institutions. The most prolific researcher in this field is Joy M from the UK, which ranks second in publication output. The most cited work is a collaborative study between researchers from the UK and Germany, focusing on teachers' experiences with CBL in chemistry education. Among academic journals, the International Journal of Science Education has published the highest number of articles on CBL, including two special issues dedicated to this area. The three most active disciplines in CBL research are social sciences, computer science, and engineering.

Furthermore, this study highlights that CBL is not only a widely recognized pedagogical approach but also an expanding research domain that extends into various fields, particularly social sciences, computer science, engineering, and teacher education. By analyzing author keywords, research trends, and contributions from different countries, institutions, and individuals, this study helps identify key directions for future research in CBL. The findings indicate that in recent years, the integration of CBL with digital technology, big data analytics, and VR has gained increasing attention from the research community, opening up new development opportunities in higher education. Additionally, the study clarifies differences in research trends across scientific databases. While Scopus tends to focus more on social sciences and education, WoS places greater emphasis on natural sciences and engineering. This suggests that the application of CBL varies across educational and disciplinary contexts, underscoring the need for further research to identify the most effective implementation models. These findings affirm that CBL research in higher education is diverse, covering a wide range of topics across multiple disciplines. However, the annual growth rate of publications remains relatively modest. To advance this field, future research should adopt a more comprehensive approach, focusing on key aspects such as faculty professional development, instructional material development, and policy frameworks to support CBL implementation. Expanding interdisciplinary research and exploring new technological integrations will be crucial for enhancing the effectiveness of CBL and its impact on higher education worldwide.

This study has some limitations related to the data and tools used. Using data from the Scopus database limits the scope and representation of the research field. While Scopus contains a large amount of data, it does not cover all scientific literature globally. The database focuses primarily on main area is social sciences. As a result, important documents from other fields may not be included. Additionally, missing

critical information such as keywords, abstracts, and authorship details could affect the data quality and the analysis results. The primary tools used in this study, Bibliometrix and VOSviewer, are mainly designed for quantitative analysis and may not provide the reliability needed for qualitative analysis. Therefore, this study only provides an overview without a detailed analysis of specific topics.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare no competing interest.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author [PNHN], upon reasonable request.

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