



The Role of Problem Based Learning in Food Safety Education

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Abstract

This study aims to examine how the problem-based learning (PBL) approach is addressed in food safety courses within food engineering education and to analyze the development trends of this research field based on existing literature. Food safety education is inherently a problem-oriented field requiring risk analysis, decision-making, and problem-solving skills in real-life contexts; therefore, student-centered teaching approaches such as PBL are considered highly relevant. The study was conducted using a mixed-methods approach, integrating bibliometric analysis and qualitative content analysis. Academic publications indexed in the Web of Science (1995–2025) and Scopus (2002–2026) databases were analyzed based on predefined criteria. In conclusion, although PBL shows strong potential in food safety education, the research field itself is still emerging and requires more systematic, diverse, and application-oriented studies to support its wider adoption in educational practice.

Keywords: Food engineering; food safety; content analysis; problem-based learning

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1. INTRODUCTION

The quality of university-level teaching and learning is garnering increased global attention (Devlin et al., 2007), and there is an escalating necessity to ensure efficient teaching at universities and to demonstrate that efficacy. University teaching is an academic pursuit necessitating extensive disciplinary knowledge and contextual experience, alongside a diverse array of professional skills and practices. The foundation for guaranteeing quality is a common understanding of what it takes to be a successful university instructor. Teachers, teaching support personnel, academic staff development, academic leaders, institutions, and the higher education industry as a whole—both domestically and globally—need to have this understanding. Effective teaching in higher education is a "contested concept" with multiple definitions (Skelton, 2004). No universally accepted definition of effective university teaching exists (Ryan, 2021), despite multiple efforts to delineate its characteristics through diverse theoretical frameworks, encompassing both qualitative and quantitative methodologies, various disciplinary perspectives (McMillan, 2007), and student viewpoints (Vulcano, 2007).

In order to offer students excellent and successful educational programs, quality assurance is essential in higher education. Establishing strong policies and frameworks that preserve and improve the quality of education offered by institutions is essential as the demand for higher education rises and changes (Altbach et al., 2023; Kehm & Teichler, 2016).

A pedagogical approach known as "problem-based learning" (PBL) teaches pupils a subject by having them solve a problem that resembles one they could encounter in real life. In this situation, the necessity to tackle a real-world problem serves as the catalyst for students' learning (Barrett & Moore, 2010). One of the key components of PBL is the use of skills to teach content. When implementing problem-based learning, a number of factors must be taken into account, including the teacher's role as a learning facilitator, students' self-directed learning, and their collaborative learning. When a teacher serves as a learning facilitator, they can motivate students by helping them see how the knowledge they are learning can be useful in their personal or professional lives (Hung & Loyens, 2012). Instead of imparting knowledge, the instructor's primary responsibility in PBL is to model for the students how experts solve problems and reason. PBL's self-directed learning component encourages students to take initiative in both the learning and problem-solving processes and helps them actively, as opposed to passively, develop certain problem-solving skills. Lastly, one of the most crucial aspects of PBL is collaborative learning in small groups, where people work together to solve issues (Simons & Baeten, 2016).

Students' knowledge is developed through the problem-based learning method, which enhances their educational experience. According to Iqbal et al., (2018), every student can consider a variety of alternatives that can raise their level of creativity. Creative thinking skills concentrate on the cognitive aspect of creativity. Since it will result in student learning outcomes, it is important to highlight and pay attention to students' creative thinking abilities during the learning process. Finding the right answers is the aim of creative thinking skills, but developing problem-solving skills is more important (Yoon et al., 2014).

Its expansion outside the conventional field of clinical education to practical fields like health sciences, business studies, and engineering was facilitated by its strong ties to workplace collaboration and interdisciplinary learning. A growing number of studies have examined PBL's effectiveness on student learning quality and the degree to which its promise of fostering self-directed learning habits, problem-solving abilities, and deep disciplinary knowledge is realized as a result of its growing practice and popularity in a variety of educational and organizational settings (Simons & Baeten, 2016; Almulla, 2020).

Food safety is a public health concern that affects all people. The US "The conditions and practices that preserve the quality of food to prevent contamination and food-borne illnesses" is how the Department of Agriculture (USDA) defines food safety (USDA, n.d.). Because it "improves economic growth of the region where food safety is practiced and enhanced," safe food helps with a number of infrastructure challenges (Mukuni & Mukuni, 2004). Despite their interests in learning about food safety and preparation, growing responsibilities for food shopping and preparation, and future roles as caregivers for infants, young children,

and elderly parents, children and teenagers' comprehension of safe food-handling knowledge and skills has received little attention. Additionally, the foodservice sector, which includes cashiers, table bussers, servers, and cooks, is where young people work the most frequently (Davich, 2002).

Both good science and just law enforcement are essential to a safe food supply. As technology develops, new laws must be passed to ensure that there is a steady supply of healthy, safe food products for people's health and well-being (Fung et al., 2018).

STEM literacy is crucial for enhancing any country's food safety system, according to researchers like Fung et al. (2018). Food safety is one of the subjects that are taught in academic and professional settings, so it is necessary to find ways to make these learning environments better. Although not all experiences are instructive, Dewey reasoned that experience and education go hand in hand. (Bredo 2014).

Knowledge retention benefits from experiences and experiential learning. For difficult disciplines like food science and other STEM courses, this becomes even more important. Because food science is such a practical subject, it is a unique course where problem-based learning may take place. For instance, teachers can involve students in resolving issues that are expected to arise during food preparation when teaching subjects like food safety. Duffrin (2003) examined this type of learning by giving first-year food science students an unstructured topic.

This study aims to examine how the problem-based learning (PBL) approach is addressed in food safety courses within food engineering education and to analyze the development trends of this research field based on existing literature.

2. RESEARCH DESIGN

This study was carried out using a mixed methods approach and a descriptive and comparative design framework. Bibliometric analysis was used in the first step to uncover the field's structural features, and content analysis was used in the second stage to offer thematic depth. By combining quantitative and qualitative data, the mixed methods approach enables a more thorough and comprehensive analysis of the research problem (Fetters & M na-Azorin, 2020). A useful technique for determining patterns of scientific production and research trends is bibliometric analysis (Braun & Clarke, 2022). Conversely, content analysis is a potent qualitative analytic method that makes it possible to systematically extract thematic structures from textual data (Braun & Clarke, 2022).

2.1. Data sources and data collection process

The data source of this research consists of academic publications indexed in the Web of Science and Scopus databases, accessed through the Istanbul Aydın University Library. In the search process, relevant studies were identified using keywords related to “problem-based learning” and “food safety education.” The search was conducted within the title, abstract, and keyword fields, and appropriate Boolean operators were used to refine the results.

The studies included in the analysis were limited to publications between 1995 and 2025 in the Web of Science database and between 2002 and 2026 in the Scopus database, based on the availability of relevant records. The obtained data were analyzed through bibliometric analysis by categorizing them under specific variables. In this context, the publications were examined in terms of distribution by year, subject area, language, country, document type (e.g., article, conference paper, review), and institutional affiliation.

Furthermore, the distribution of studies across years was analyzed to reveal research trends, while subject areas were examined to determine the disciplinary focus of the studies. Language and country distributions were evaluated to identify the global reach of the research, and institutional affiliations were analyzed to

determine contributing organizations. The document types were also considered to ensure the academic quality and publication characteristics of the studies.

2.1.1. Bibliometric analysis

Using descriptive statistics, the papers were examined in the first phase of the study based on the following standards:

- Year,
- Document type,
- Country
- Souch type
- language,

Tables and graphs were used to display the collected data.

2.1.2. Content analysis

In the second phase of the research, the selected studies were examined using the qualitative content analysis method. In the content analysis, recurring concepts and themes were identified by considering the aims, methods, and results sections of the studies.

Coding generally involves

1. Obtaining information that is necessary to address research questions
2. Selecting, classifying, or labeling content
3. Classifying content according to the main ideas being conveyed, similarities, differences, sources, etc.

The following primary topics emerged from the analysis:

- Design of instruction
- Interaction types
- Feedback systems
- Inspiration
- Inclusive and accessible methods

These elements were assessed in relation to theoretical frameworks found in the literature that explain student engagement in digital learning settings.

2.1.3. Coding reliability

The coding procedure was done methodically to guarantee the content analysis's dependability. The researcher first completed preliminary coding, then reexamined the identified themes and verified that the codes were consistent. Conceptual overlaps were removed, and similar statements were placed under the same theme category. The inclusivity and distinctiveness of the themes were assessed, and comparative analysis was used to make the differences between themes in the coding process clear. The final code list was produced after the theme structure that emerged from this procedure was examined once more. As a result, the analysis procedure was guaranteed to be internally consistent.

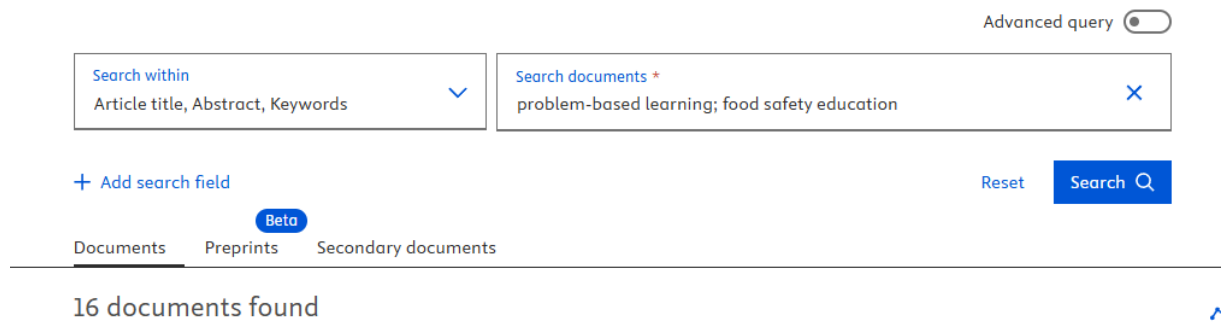
3. FINDINGS

3.1. Findings relating to the scopus database

This section presents the findings from a systematic search of the Web of Science and Scopus databases.

Figure 1

Sixteen studies were identified using the keywords established in the Scopus database.



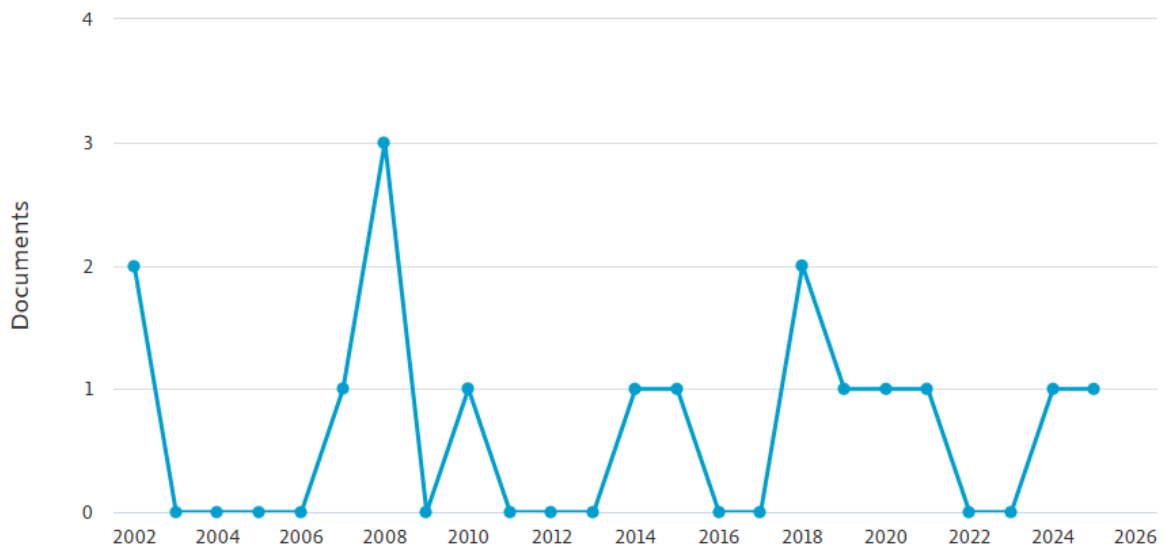
Sixteen studies were identified using the keywords established in the Scopus Database.

3.1.1. Publication distribution by year in the scopus database

Figure 2

Distribution of publications by year in the scopus database

Documents by year



An analysis of the publication distribution of problem-based learning and interactive studies involving food engineering students in the Scopus database reveals a lack of publications throughout the periods of 2003-

2006, 2011-2013, 2016-2017, and 2022-2023. An increase in the number of publications on this topic is observed between 2006-2008. 2007 stands out as the year with the highest number of publications. Overall, the graph indicates that the number of publications in this field is limited between 2002-2026. In general, the graph shows that the number of research studies on this topic is not very high. Overall, the graph indicates that this area of research has not been extensively studied, particularly in recent years, in a way that would yield significant results.

3.1.2. Document type distribution in the scopus database

Table 1

Distribution of scopus publications by document type

Document Type	Publication Number	%
Article	11	68.75
Conference Paper	2	12.5
Review	2	12.5
Note	1	6.25
Toplam	16	100

Although the number of article-type publications is not very high, it shows that there is a certain literature on the subject. The existence of conference proceedings and reviews indicates that the topic is in a formative phase and is actively debated in academic circles.

3.1.3. Country-Based distribution of publications in the scopus database

Table 2

Distribution of scopus publications by country (top 11 countries)

Country	Number of Publications	%
USA	8	50
United Arab Emirates	1	6.25
Switzerland	1	6.25
South Africa	1	6.25
Rwanda	1	6.25
Netherlands	1	6.25
Malaysia	1	6.25
Italy	1	6.25
Ireland	1	6.25
France	1	6.25
Belgium	1	6.25

The country-based distribution of publications in the Scopus database demonstrates a highly uneven pattern, with the United States accounting for 50% of the total output. This finding clearly indicates that the

research field is predominantly driven by a single country. In contrast, the remaining countries each contribute only 6.25% of the publications, reflecting a fragmented and limited level of participation.

This imbalance suggests that the development of research on problem-based learning in food safety education is not yet globally widespread and remains concentrated in specific academic contexts. Although the inclusion of countries from Europe, Asia, and Africa points to an emerging international interest, their relatively low contribution levels indicate that the field is still in an early stage of global diffusion.

Furthermore, the dominance of the United States may be associated with its well-established research infrastructure, funding opportunities, and strong emphasis on innovative pedagogical approaches in higher education. However, the lack of substantial contributions from other regions highlights a need for more diverse and cross-cultural research efforts to ensure the broader applicability and generalizability of findings in this field.

3.1.4. Source type distribution in the scopus database

Table 3

Distribution of scopus publications by source type

Source Type	Number of Publications	%
Journal	14	87.5
Conference Proceedings	2	12.5
Total	16	100

Research is mostly conducted on platforms that adhere to academic quality norms, as evidenced by the fact that 87.5 % of articles are published in peer-reviewed journals. The fact that conference papers account for 12.5% of the content indicates that the field is undergoing a strong academic development process and has an open structure for discussion.

3.1.5. Language distribution in the scopus database

Table 4

Language distribution of scopus publications

Language	Number of Publications	%
English	15	93.75
French	1	6.25
Total	16	100

93.75% of publications are in English, indicating that this field is highly dependent on English-based academic literature. Outside of English, only one publication exists, and it is entirely in French. This suggests

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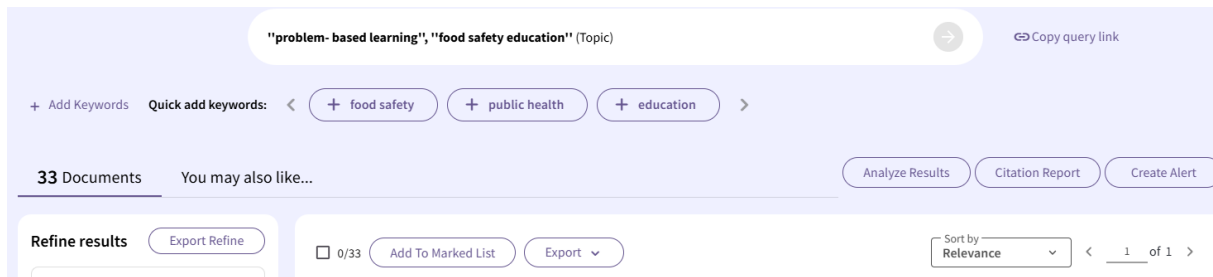
that English is the primary language of academic communication in the research field and that the studies may have little visibility in foreign indexes.

3.2. Findings relating to the web of science database

This section presents the findings from a systematic search of the Web of Science and Scopus databases.

Figure 3

Search query and results obtained from the web of science database



Thirty-three studies were identified using the keywords established in the Web of Science Database.

3.2.1. Analysis of publication trends over time in the web of science database

Table 5

Publication distribution by year in the web of science database

Year	Number of Publications	%
1995	1	3.03
2002	1	3.03
2005	1	3.03
2006	2	6.06
2008	1	3.03
2010	1	3.03
2013	1	3.03
2014	2	6.06
2015	1	3.03
2016	2	6.06
2017	2	6.06
2018	3	9.09
2019	2	6.06
2020	2	6.06
2021	2	6.06
2022	1	3.03
2023	2	6.06
2024	4	12.12
2025	2	6.06
Total	33	100

An analysis of the publication distribution of problem-based learning studies in food engineering education within the Web of Science database reveals a fluctuating but gradually increasing trend over time. Although the earliest publication dates back to 1995, the number of studies remained relatively low and sporadic until the mid-2010s.

A more noticeable increase in research output is observed after 2016, particularly between 2017 and 2020, indicating a growing academic interest in the field. This upward trend continues in the following years, with 2024 emerging as the peak year, accounting for the highest number of publications.

Despite these increases, the overall number of studies remains limited, and the distribution across years is not entirely consistent. The presence of intermittent increases rather than a steady growth pattern suggests that the field has not yet reached full maturity in terms of sustained research production.

Overall, these findings indicate that research on problem-based learning in food safety and food engineering education is still developing, with increasing attention in recent years but without a stable and continuous growth trajectory.

3.2.2. Analysis of document types in the web of science database

Table 6

Distribution of web of science publications by document type

Document Type	Publication Number	%
Article	24	72.73
Proceeding Paper	8	24.24
Book Chapters	2	6.06
Editorial Material	1	3.03

*Note: The total number of document types exceeds the total number of publications (N=33) because Some studies are classified under more than one document type in the Web of Science database.

The distribution of document types in the Web of Science database indicates that the majority of publications are journal articles (72.73%), highlighting the strong presence of peer-reviewed research in the field. Proceeding papers (24.24%) also constitute a notable proportion, suggesting that the field continues to evolve through academic conferences and ongoing scholarly discussions. The presence of book chapters (6.06%) and editorial materials (3.03%) further reflects the diversity of publication formats, indicating that the research area is expanding conceptually as well as academically. It should be noted that the total count of document types exceeds the number of publications due to the multiple classification of some studies within the Web of Science database. Overall, these findings suggest that the field has established a solid academic foundation while continuing to develop through various scholarly communication channels.

3.2.3. Analysis of country-based distribution in the web of science database

Table 7

Distribution of web of science publications by country (top 18 countries with the most publications)

Country	Number of Publications	%
USA	15	42.86%
Australia	2	5.71%
France	2	5.71%
People R China	2	5.71%
Belgium	1	2.86%
Brazil	1	2.86%
Colombia	1	2.86%
Egypt	1	2.86%
England	1	2.86%
Greece	1	2.86%
Italy	1	2.86%
Malaysia	1	2.86%
Russia	1	2.86%
Rwanda	1	2.86%
Serbia Monteneg	1	2.86%
Slovakia	1	2.86%
Switzerland	1	2.86%
THAILAND	1	2.86%

*Note: The total number of publications exceeds the total number of documents (N=33) because some studies are associated with multiple countries due to international co-authorship.

The country-based distribution of publications in the Web of Science database reveals a highly concentrated yet globally dispersed research pattern. The United States emerges as the leading contributor, accounting for 42.86% of the total publications, indicating a dominant role in shaping the research agenda in this field.

In contrast, Australia, France, and the People’s Republic of China each contribute 5.71% of the publications, suggesting a moderate level of engagement from these countries. The remaining countries, including Belgium, Brazil, Colombia, Egypt, England, Greece, Italy, Malaysia, Russia, Rwanda, Serbia and Montenegro, Slovakia, Switzerland, and Thailand, each account for 2.86% of the total output, reflecting a relatively limited but diverse international participation.

This distribution demonstrates that while the research field has a broad geographical reach, it remains unevenly developed across countries. The strong dominance of the United States may be associated with its

advanced research infrastructure, funding capacity, and emphasis on innovative educational approaches. Meanwhile, the presence of multiple countries with low publication frequencies suggests that the field is still emerging globally and has not yet reached a level of balanced international representation.

It should also be noted that the total number of country-based records exceeds the total number of publications due to the inclusion of multiple country affiliations in some studies, reflecting patterns of international collaboration.

Overall, these findings indicate that research on problem-based learning in food safety education is internationally recognized but remains concentrated in a few leading countries, highlighting the need for more inclusive and geographically diverse research contributions.

3.1.1. Analysis of institutional distribution in the web of science database

Table 8

Top contributing institutions in the web of science database

Affiliations	Count
CORNELL UNIVERSITY	2
UNIVERSITY OF MISSOURI SYSTEM	2
AGROPARISTECH	1
ARMY MEDICAL UNIVERSITY	1
ASSOC COORDINAT TECH IND ALIMENTAIRE	1
BENI SUEF UNIVERSITY	1
BUTLER UNIVERSITY	1
CHARLES DARWIN UNIVERSITY	1
CHONGQING MEDICAL UNIVERSITY	1
CLEMSON UNIVERSITY	1
COLORADO SCHOOL OF PUBLIC HEALTH	1
COMMONWEALTH SCIENTIFIC INDUSTRIAL RESEARCH ORGANISATION CSIRO	1
CONSTANTINE THE PHILOSOPHER UNIVERSITY IN NITRA	1
DERAYA UNIVERSITY	1
ECOLE NATIONALE VETERINAIRE DE TOULOUSE	1
EGYPTIAN KNOWLEDGE BANK EKB	1
GHENT UNIVERSITY	1
INDIANA UNIVERSITY BLOOMINGTON	1
INDIANA UNIVERSITY SOUTH BEND	1
INDIANA UNIVERSITY SYSTEM	1
INSTITUTE OF INORGANIC CHEMISTRY SAS	1
LABORATOIRE NATIONAL DE METROLOGIE ET D ESSAIS LNE	1
LAMAR UNIVERSITY	1
MINIA UNIVERSITY	1
MISSOURI UNIVERSITY OF SCIENCE TECHNOLOGY	1
NAVAL MEDICAL UNIVERSITY	1
NORTH CAROLINA STATE UNIVERSITY	1
RUSSIAN BIOTECHNOLOGICAL UNIVERSITY ROSBIOTECH	1
SANIT SURVEILLANCE CTR STATE SAO PAULO	1

SLOVAK ACADEMY OF SCIENCES	1
SOURDOUGHS INT	1
TEXAS STATE UNIVERSITY SYSTEM	1
TUFTS UNIVERSITY	1
UNIV GLOBAL HLTH EQU	1
UNIVERSIDAD DE LOS ANDES COLOMBIA	1
UNIVERSIDADE DE SAO PAULO	1
UNIVERSIDADE FEDERAL DE SAO PAULO UNIFESP	1
UNIVERSITE DE TOULOUSE	1
UNIVERSITE PARIS SACLAY	1
UNIVERSITY OF AEGEAN	1
UNIVERSITY OF BERN	1
UNIVERSITY OF CALIFORNIA DAVIS	1
UNIVERSITY OF CALIFORNIA SYSTEM	1
UNIVERSITY OF DELAWARE	1
UNIVERSITY OF HONG KONG	1
UNIVERSITY OF IDAHO	1
UNIVERSITY OF MISSOURI COLUMBIA	1
UNIVERSITY OF NOTRE DAME	1
UNIVERSITY OF NOVI SAD	1
UNIVERSITY OF PADUA	1
UNIVERSITY OF PUERTO RICO	1
UNIVERSITY OF PUERTO RICO MEDICAL SCIENCES CAMPUS	1
UNIVERSITY OF QUEENSLAND	1
UNIVERSITY OF READING	1
UNIVERSITY OF SADAT CITY	1
UNIVERSITY OF TUN HUSSEIN ONN MALAYSIA	1
UNIVERSITY OF ZURICH	1
WASHINGTON STATE UNIVERSITY	1
WATERFIELDS LLC	1
XUZHOU MEDICAL UNIVERSITY	1

Note: This table presents the most productive institutions in the dataset. A large number of institutions contributed only one publication each and are not included to ensure clarity and readability of the table.

The institutional distribution of publications in the Web of Science database, based on the most productive institutions, indicates a relatively dispersed research structure. Among the listed institutions, Cornell University and the University of Missouri System stand out as the leading contributors, each with two publications. The remaining institutions, including AgroParisTech, Army Medical University, Assoc Coordinat Tech Ind Alimentaire, Beni Suf University, Butler University, Charles Darwin University, and Chongqing Medical University, each contributed one publication.

This pattern suggests that even among the most productive institutions, there is no strong institutional dominance. The fact that only a small number of institutions have contributed more than one publication indicates that the research field lacks institutional concentration and is characterized by a distributed and fragmented structure.

Furthermore, considering that many other institutions in the dataset contributed only a single publication (not shown in the table), it can be inferred that research on problem-based learning in food safety education

is conducted across a wide range of institutions rather than being driven by a few specialized research centers. Overall, these findings indicate that the field demonstrates a broad but dispersed institutional participation, reflecting its emerging nature and the absence of well-established research clusters.

3.2.5 Analysis of language distribution in the web of science database

Table 9

Language distribution of web of science publications

Language	Number of Publications	%
English	33	100

The research field is done using the worldwide academic language of communication, as evidenced by the fact that all publications are in English. This makes the studies more accessible worldwide, but it also raises the possibility that there may not be as much research done in regional languages.

3.3. Comparative findings

Table 10

Comparative analysis of scopus and web of science findings

Dimension	Scopus Findings	Web of Science Findings
Publication Trend	Irregular and fragmented distribution across years	Fluctuating but gradually increasing trend, especially after 2016, with a peak in 2024
Time Coverage	Limited and discontinuous (2002–2026)	Broader and more continuous (1995–2025)
Document Type	Majority articles (68.75%), indicating emerging academic structure	Majority articles (72.73%), indicating a more established and peer-reviewed research base
Research Maturity	Emerging and developing	Developing with a more structured and consistent pattern
Country Distribution	Highly concentrated (USA dominant, 50%)	More diversified but still USA-led (42.86%), with broader international participation
Global Representation	Limited international spread	Wider global representation across multiple regions
Institutional Distribution	Limited institutional diversity	Highly dispersed across institutions, with no dominant research centers
Research Structure	Fragmented and less consistent	More systematic, yet still developing
Language	Mostly English (93.75%), limited linguistic diversity	Fully English (100%), reflecting standardized academic communication

Table 10 presents a comparative overview of the findings obtained from the Scopus and Web of Science databases. The comparison indicates that while both databases reflect an emerging research field, notable differences exist in terms of publication trends, coverage, and structural development.

The Web of Science database demonstrates a more consistent and gradually increasing publication trend, particularly after 2016, with a peak observed in 2024. In contrast, the Scopus database exhibits a more irregular and fragmented distribution of publications across years.

In terms of coverage, the Web of Science database provides a broader temporal range (1995–2025), whereas the Scopus database reflects a more limited and discontinuous scope. Similarly, while both databases are dominated by journal articles, the slightly higher proportion in Web of Science suggests a more established and peer-reviewed research base.

Furthermore, although both databases indicate a strong dominance of the United States, the Web of Science database reflects a more diverse international distribution and wider institutional participation. This suggests a comparatively more globalized and structured research landscape. Overall, these findings indicate that although the field of problem-based learning in food safety education is still developing, it shows clearer signs of maturity, continuity, and internationalization within the Web of Science database compared to Scopus.

4. DISCUSSION

The literature on the problem-based learning approach in food safety education is still in its infancy, according to the study's findings from the Scopus and Web of Science databases. Results from the Scopus database show that the distribution of publications by year is erratic and discontinuous. This indicates that academic output is not developing steadily and that the research field has not yet attained a continuous process of knowledge production. Bibliometric studies demonstrate that the research goal has not yet been fully institutionalized and that such uneven distributions are typically indicative of the early phases of the field's development (Donthu et al., 2021; Aria & Cuccurullo, 2017).

The majority of the article type in both databases, when analyzed in terms of document type, suggests that the area is evolving within the parameters of academic quality standards. The increased percentage of papers, particularly in the Web of Science database, suggests that the discipline is progressively shifting toward a more academically developed and peer-reviewed structure. Nonetheless, the existence of conference papers and review studies in the Scopus database indicates that the topic is still developing and has a structure that is amenable to scholarly discussion. According to the literature, the coexistence of several publication forms in developing disciplines suggests that the field's conceptual framework is still developing (Zupic & Čater, 2015).

The nation distribution results show that the United States plays a major role in both databases. This condition is consistent with data demonstrating that academic output is concentrated in nations with robust support for research and widespread use of innovative teaching methods in higher education (Altbach et al., 2023). Furthermore, the Web of Science database's inclusion of a larger variety of nations suggests that the subject of study is more globally dispersed. Nonetheless, research indicates that worldwide research production tends to cluster in specific hubs, which is consistent with the reality that this distribution is still uneven (Marginson, 2018).

Research is carried out by many different institutions, and there is no discernible institutional concentration when looking at the institutional distribution, particularly in the Web of Science database. This suggests that the field has not yet organized itself around specialized centers and robust research clusters. It is highlighted that some universities and research institutions play a pioneering role in the institutionalization of research topics (Kehm & Teichler, 2016). The results indicate that research on problem-based learning in food safety education has not yet advanced to this point.

The fact that English is the most widely used language in both databases illustrates how international academic communication is. The use of English as a common language in scientific production raises research's profile internationally, but it may also result in a lack of representation of studies carried out in regional languages in the literature (Hyland, 2016).

The comparison of the Web of Science and Scopus databases offers important insights into the dynamics of the field's development. The field has undergone a more methodical development process, as seen by the Web of Science database's rising and more steady publishing trend, especially after 2016. On the other hand, the Scopus database's disjointed and erratic structure indicates that the field of study has not yet developed a thorough research agenda. This discrepancy may result from the publications that are covered, the databases' indexing standards, and the fact that the discipline is represented on multiple academic platforms at different stages of development (Mongeon & Paul-Hus, 2016).

Consequently, the results show that while research on the problem-based learning approach in food safety education has started to get attention worldwide, it has not yet reached complete maturity, institutionalization, or development into a well-rounded area of study. This situation highlights the necessity for future research to be more methodical, multidisciplinary, and internationally collaborative.

5. RESULTS AND SUGGESTIONS

This study used bibliometric and content analytic techniques based on the Scopus and Web of Science databases to review the literature on the problem-based learning approach in food safety education. The results show that studies are concentrated in specific nations, the research field is still in its infancy, and there are few publications. The field has not yet established a stable development phase, as seen by the erratic and discontinuous distribution of publications by year, particularly in the Scopus database. On the other hand, the Web of Science database's upward trend, especially after 2016, and the 2024 publishing peak demonstrate that scholarly interest in the topic has grown dramatically in recent years.

According to research findings, problem-based learning offers a lot of potential for teaching food safety, however studies in this area are still not systematic or standardized enough. The unequal distribution among nations and institutions, in particular, indicates that the field of study has not advanced evenly globally. The United States' strong position in both databases indicates a concentration of academic output in specific areas.

Some suggestions for further research can be made in light of these results. First, more thorough, multidisciplinary, and long-term study on the problem-based learning approach in food safety education is required. Specifically, information gathered from other nations and educational systems will help advance the area in a more equitable and comparative way.

Second, strengthening the research field at the institutional level is crucial. In addition to increasing academic output, international partnerships between universities and research institutes will aid in the development of specialized research clusters.

Thirdly, more experimental and applied research examining the real-world implications of the problem-based learning approach in food safety education is advised. These investigations will advance the subject by producing results that are both theoretical and practice-oriented.

Lastly, the area will become more inclusive and accessible as a result of the inclusion of studies carried out in various languages in the worldwide literature and the rise in their academic visibility.

Overall, more methodical, cooperative, and practice-oriented research is required to fully realize the great development potential of the literature on the problem-based learning approach in food safety education.

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