REVIEW ARTICLE

Global bibliometric analysis of pharmacists' competency exam and educational trends

Dimas Aditya Suhendar[1], Anna Wahyuni Widayanti[2], Nanang Munif Yasin[3]

[1]Master Program of Pharmacy Management, Faculty of Pharmacy, Universitas Gadjah Mada, Yogyakarta, Indonesia
[2]Department of Pharmaceutics, Faculty of Pharmacy, Universitas Gadjah Mada, Yogyakarta, Indonesia
[3]Department of Pharmacology and Clinical Pharmacy, Faculty of Pharmacy, Universitas Gadjah Mada, Yogyakarta, Indonesia

Corresponding Author: Anna Wahyuni Widayanti **Email:** wahyuni_apt@ugm.ac.id

Received: 18 October 2024 **Revised:** 14 Decmber 2024 **Accepted:** 15 December 2024 **Available online:** May 2025
DOI: 10.55131/jphd/2025/230225

ABSTRACT

In 2020, data from 194 WHO countries showed 51 million health workers, including 3.7 million pharmacists, emphasizing competency-based education (CBE) and demanding competency exams in each country. Therefore, this research aimed to map global trends, international relationships, and differences in pharmacists' competency exam methods using bibliometric analysis. A bibliometric analysis of 597 articles published between 2014 and 2024 in Scopus and Web of Science was conducted using RStudio and Bibliometric, including performance analysis, science mapping, as well as network analysis to uncover publication trends, research clusters, and knowledge differences. Findings showed that the United States led in publication volume (330 articles), followed by Canada and Saudi Arabia. International partnerships were present in 13.57% of publications, with Saudi Arabia showing a particularly high cross-country relationship rate. During this research, dominant themes included pharmacy education, structured clinical exams, and interprofessional relationships. The American Journal of Pharmaceutical Education was the most prolific source, reflecting a focus on advancing competency-based learning. This research identified disparities in pharmacists' competency exam methods and showed the need for standardized global frameworks associated with local contexts. Innovations such as AI-driven assessments and interprofessional education offered promising solutions for improving competency evaluation. In addition, recommendations included improving the relationship between academic institutions and regulatory bodies, incorporating advanced technologies, as well as associating exams with healthcare needs to improve the quality of pharmacists' education. By addressing knowledge differences and promoting innovative assessment strategies, this research contributed to global efforts in strengthening pharmacists' competencies and advancing equitable and high-quality education according to the Sustainable Development Goals (SDGs).

Keywords:
bibliometric analysis; pharmacists; pharmacy licensure; pharmacy education; competency-based education

Citation:
Dimas Aditya Suhendar, Anna Wahyuni Widayanti, Nanang Munif Yasin. Global bibliometric analysis of pharmacists' competency exam and educational trends. J Public Hlth Dev. 2025;23(2):379-397 (https://doi.org/10.55131/jphd/2025/230225)

INTRODUCTION

World Health Organization (WHO) estimated approximately 51 million healthcare workforce globally in 2020, based on data from its 194 member countries. The global pharmacists' workforce was 3.7 million, which was distributed as follows including 0.09 million in Africa, 0.6 million in the Americas, 1.3 million in Southeast Asia, 0.6 million in Europe, 0.2 million in the Eastern Mediterranean, and 0.8 million in the Western Pacific, respectively. As the number of pharmacists increases, competence-based education has become a top focus for improving as well as strengthening healthcare workers, guided by the global competency framework and assessed by pharmacists' competency exams.[1]

A competency exam ensures that pharmacists acquire the knowledge, ability, and conduct requirements for independent practice according to service standards while protecting patients and the general public. Countries have varying requirements for this exam, including written, oral, as well as Objective Structured Clinical Exam (OSCE), and in certain cases, practical training or internship requirements are also mandatory.[2] Countries with centralized healthcare systems, such as those in Europe, have standardized and uniform competency requirements. In contrast, decentralized countries such as the United States have varying requirements across states, reflecting flexibility and diversity. For example, in Ireland, the School of Pharmacy administers the test, whereas graduates from accredited pharmacy schools in Portugal can apply to the Portuguese Pharmaceutical Society without taking the national exam. Furthermore, some countries align their registration exams with national competency frameworks, such as the United States and Canada, where exams are designed to assess competencies using accreditation standards established by organizations such as the Accreditation Council for Pharmacy Education (ACPE) and the Canadian Council for Accreditation of Pharmacy Programs. By linking exams to these frameworks, accreditation bodies help maintain high education standards while providing feedback for academic institutions to refine curricula and enhance the quality of pharmacy education.[7]

The importance of competency-based education (CBE) shows the necessity for comprehensive research of pharmacists' competency exams globally, including a bibliometric analysis. Bibliometric investigations, using algorithms and statistics, provide an objective method to analyze literature, identify trends, gaps, and major contributions, as well as track scientific evolution.[3] Previous bibliometric research on these exams has primarily focused on OSCE mapping, with descriptive investigations from developed countries covering topics such as student perceptions and OSCE assessments.[6] However, competency exams include OSCE and also written, oral, as well as competency-based assessments, which vary by country.[7] Therefore, this research aimed to conduct further bibliometric analysis to map trends, publication productivity, citation patterns, and author relationships in global competency exams to support the Sustainable Development Goals (SDGs) and improve the quality of pharmacists' education.[4,5]

METHODS

This research used bibliometric analysis methods to examine trends and developments in pharmacists' competency exams in various countries. The method was selected for its ability to analyze publication and citation data with greater objectivity and broader coverage.[4] Compared to systematic reviews and meta-analyses, which typically examine 50 to

300 sources, bibliometric analysis efficiently reviewed more than 500 pieces of literature. The process was conducted in four stages, which included 1) determining the objectives and scope, 2) selecting a bibliometric analysis method, 3) collecting data, and 4) conducting analysis and reporting the results.[8]

During the investigation, performance analysis and science mapping methods developed with network analysis were combined to show the competency exam methods of pharmacists in different countries. Performance analysis used publication and citation metrics to describe research productivity as well as impact. In addition, science mapping identified relationships between authors, reference relationships, and main research themes. Network analysis grouped documents with similar themes, facilitating the analysis and understanding of relationships between articles in a research field. This grouping also helped to identify major trends and developments in the field.[8, 9, 21]

The literature search strategy involved topic identification, searching, screening, and selection based on eligibility criteria.[10] During the investigation, literature collection was conducted through databases Scopus and Web of Science, focusing on articles published in the 2014-2024 period. Searches were performed using keywords and Boolean functions, covering "Pharmacy competency exam", OR "Pharmacist licensure", OR "Pharmacist certification". Following this discussion, the types of publications considered included articles, review articles, books, chapter books, proceeding papers/conference papers, and categories of early access, respectively.

A literature search was conducted on August 24, 2024, using predefined criteria and leveraging Scopus and Web of Science databases to access relevant articles. While these databases offer high-quality resources, there were limitations, including a bias toward English-language literature, restricted access due to high costs, limited coverage of gray literature, risks of data duplication, and dependence on effective search keywords. To address these limitations, a filtering process excluded non-English articles, irrelevant topics, and publication types such as letters, editorials, meeting abstracts, as well as notes. The datasets, obtained in BibTex (bib) format, were combined using RStudio to identify duplicates and compile comprehensive information, which was subsequently analyzed in bibliometric research.[11,12]

The dataset obtained was processed using RStudio, it was then analyzed and visualized with Bibliometric by applying the Biblioshiny tool. Bibliometric analysis in this research was conducted using the methods of performance analysis, science mapping, and development with network analysis. During this investigation, performance analysis focused on two metrics, namely Total Publications (TP) and Total Citations (TC). Science mapping covered co-word analysis and co-authorship analysis in the research. Additionally, bibliometric analysis was also developed through network exam, which covered network metrics and clustering.[13] The analysis results were then visualized, including the keyword co-occurrence network, three-field plot co-authorship, and bibliographic coupling. This process was shown with document clustering for easier interpretation of the results and strengthened the findings according to the research objectives.[14]

RESULTS

The results of literature searches based on criteria reached a total of 768 articles (Scopus (n = 153) and Web of Science (n = 615)). Article screening was

conducted by excluding 24 articles not published in English, 28 articles with irrelevant topics, 8 letters, 30 editorial materials, 7 meeting abstracts, and 17 notes. Moreover, the dataset was processed using the software RStudio and succeeded in identifying 57 duplicate articles. A total of 156 articles were excluded from the analysis because the articles did not meet the eligibility criteria. In addition, a total of 597 articles qualified for further analysis in the bibliometric research. The literature search strategy from databases Scopus and Web of Science is shown in Figure 1.

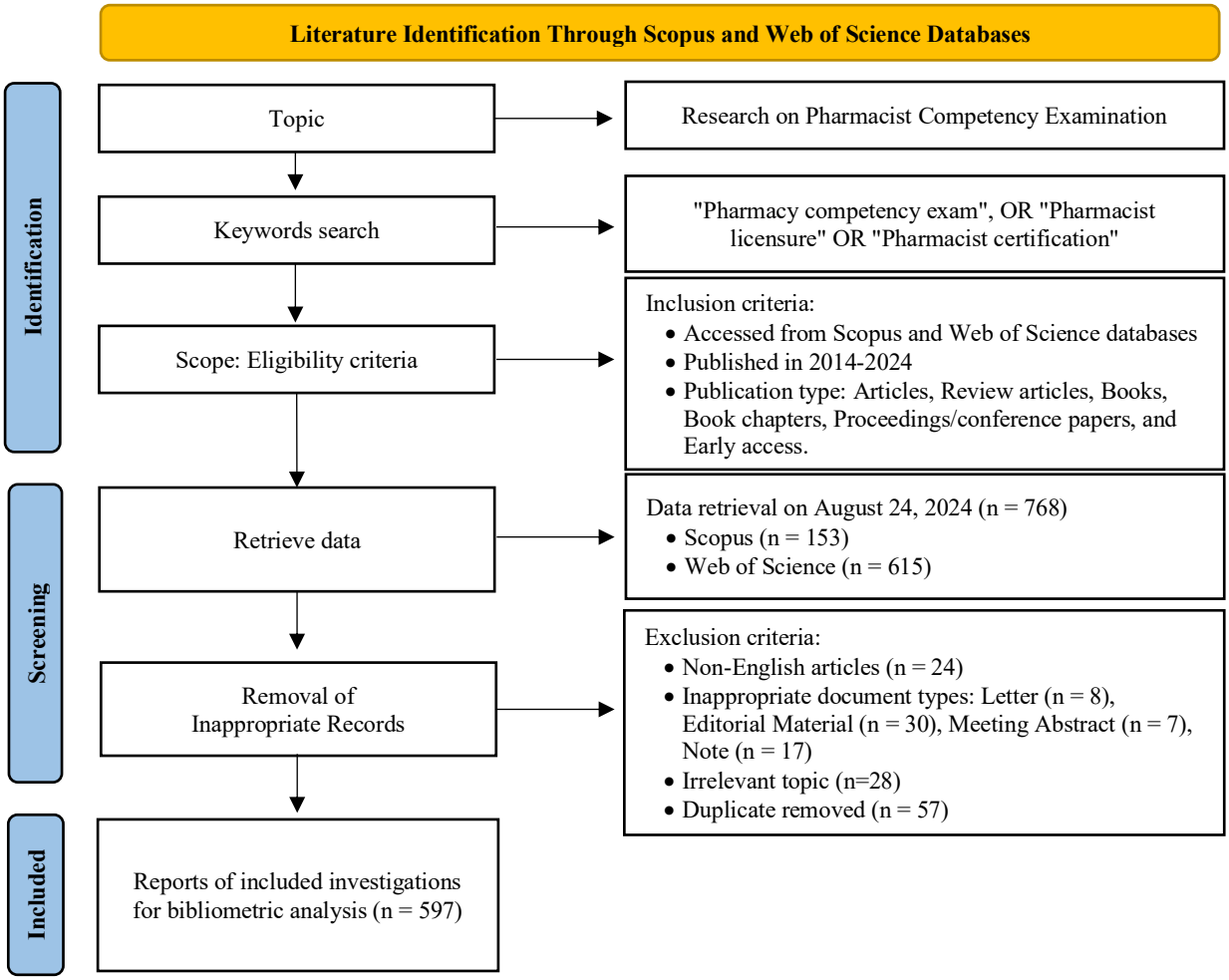

Figure 1. Literature Search Strategy from Databases Scopus and Web of Science

Performance analysis

Data analysis using Biblioshiny from 2014 to 2024 revealed 166 journal sources contributing to publications on pharmacists' competency exam methods, with an annual growth rate of 11.92%. Each journal's productivity was assessed based on its relevance and contribution to the topic, with the objective of identifying prominent journals that published high-quality research and contributed to the dissemination of knowledge.[14,15] Table 1 shows the journals with the highest publication productivity in the following order. The American Journal of Pharmaceutical Education took the top spot with 93 articles, followed by Currents in Pharmacy Teaching and Learning with 77 articles. In addition, the Journal of American Pharmacists Association and Pharmacy Education each published 30 articles, followed by the journal Pharmacy with 27 articles. The American Journal of Health-System Pharmacy contributed 23 articles, while Research in Social & Administrative Pharmacy published 20

articles. Journal of the American College of Clinical Pharmacy recorded 18 articles, followed by BMC Medical Education with 15 articles, and Saudi Pharmaceutical Journal occupied the last position with 10 articles. Generally, these data showed high productivity in scientific publications related to pharmacists' competency exam methods, with several journals contributing significantly.

Table 1. Journal with the highest article publication productivity in 2014-2024 period

Journal Name	Number of Articles
American Journal of Pharmaceutical Education	93
Currents in Pharmacy Teaching and Learning	77
Journal of the American Pharmacists Association	30
Pharmacy Education	30
Pharmacy	27
American Journal of Health-System Pharmacy	23
Research in Social & Administrative Pharmacy	20
Journal of the American College of Clinical Pharmacy	18
BMC Medical Education	15
Saudi Pharmaceutical Journal	10

International relationships in the publication of scientific articles reached 13.57% of the TP produced through cross-country relationships, known as Multiple Country Publications (MCP). Figure 2 shows the 10 countries with the highest contributions during the analyzed period, including the United States, Canada, Saudi Arabia, Australia, Japan, the United Kingdom, China, Malaysia, Lebanon, and South Korea. Following this discussion, the United States dominated with 330 articles (55.3%), where 314 articles were Single Country Publications (SCP) and 16 articles were MCPs (4.8%). Canada was second with 31 articles (5.2%), where 16.1% were MCPs. Subsequently, Saudi Arabia produced 28 articles (4.7%) with a significant MCP contribution of 35.7%, showing strong international relationships. Australia published 23 articles (3.9%) with an MCP percentage of 17.4%, while Japan recorded 21 articles (3.5%) without international relationship (MCP 0%). The United Kingdom with 19 articles (3.2%), showed an important role in global relationships, with MCP reaching 31.6%. China had 11 articles (1.8%) with an MCP of 18.2%, while Malaysia showed the highest MCP percentage among these countries, having 40% of the 10 articles published. Lebanon had nine articles (1.5%) and an MCP of 22.2%, and South Korea published eight articles (1.3%) with no MCP contribution. The high percentage of MCP in some countries, such as Canada and Saudi Arabia, reflected trends toward cross-national relationships in pharmaceutical research as well as pharmacists' education by further strengthening global knowledge networks in the field.

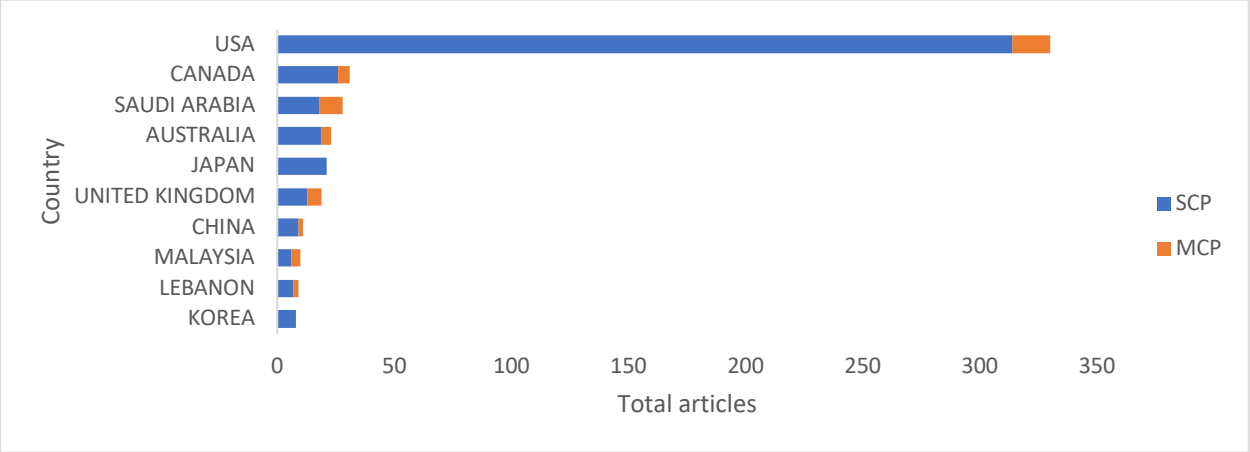

Figure 2. The country with the highest article publication productivity in 2014-2024 period

In Figure 3, author productivity in the form of TC and citations per year (TCpY) was shown through variations in the brightness as well as the size of the circles along the time axis. A larger circle implied more articles that were published by the author, while the intensity of the color signified how often the article was cited each year. Among the 2,815 authors who contributed to the publication of articles, the top 10 authors contributed significantly. "MCKEIRNAN K" was at the top with 10 articles and annual citations reaching 3.20 in 2020. Following this discussion, the most relevant and cited research discussed the impact of pharmacists' certification on the technical development of pharmaceutical services, professional adaptation, career commitment, and improvement of work skills.[16] "CHEN A" followed "MCKEIRNAN K" on the list with nine articles and citations reaching up to 7.00 per year in 2023. Moreover, the relevant article discussed the assessment of CBE in the health professions curriculum.[17] "SUZUKI S" also appeared as a dominant contributor, with eight articles and a TCpY of 5.83 in 2019. Research was conducted concerning the impact of pharmacists' certification on the quality of chemotherapy in Japan.[18]

Other authors such as "DAUGHERTY K" and "MAERTEN-RIVERA J" also contributed seven articles each, where "DAUGHERTY K" achieved the highest TCpY of 4.00 in 2020. "BATES I" had the highest TCpY of 5.75 in 2021, with 6 articles in all. Relating to this discussion, "DESSELLE S" with five articles was also quite prominent, with the highest TCpY of 3.44 in 2016. Other authors, such as "JOHNSON S", "KELSCH M", and "A. A", each having a lower frequency of five articles, remained relevant in certain years, while "JOHNSON S" had 14 citations in 2019. These contributions showed the importance of lead authors among thousands of other contributors in academic publications.

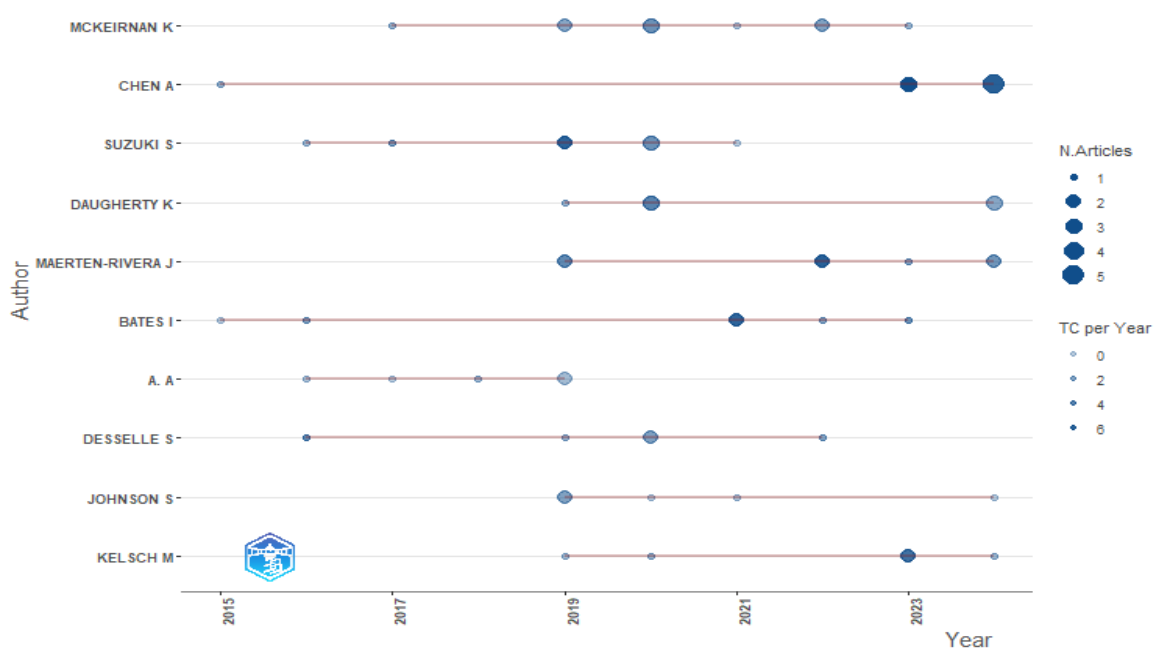

Figure 3. Author with the highest productivity of article publications and citations in 2014-2024 period

Science mapping

A keyword co-occurrence network visually represents the relationship between keywords in publications, providing insights into a scientific field's intellectual structure through bibliometric analysis. Nodes represent keywords, and connecting lines (edges) indicate how often keywords appear together. Line thickness shows the strength of the relationship, while node size reflects keyword importance. Color highlights clusters of related topics. This analysis reveals trending topics, connections between different areas, and identifies research-intensive fields.[11,19]

Figure 4 shows that the keyword "pharmacy" appeared as the largest node, signifying that the topic was the most dominant. Several topics that were closely related to these keywords were grouped in clusters with different colors. Blue clusters dominated the network, showing that most of the research was found around this main theme, while red represented "pharmacy education", purple for "pharmacists" and green signified "knowledge". The cluster in orange referred to the keyword "interprofessional education", brown color represented "objective structure clinical exam", gray signified "practice", and pink corresponded to "community pharmacists" with the fewest linkages.

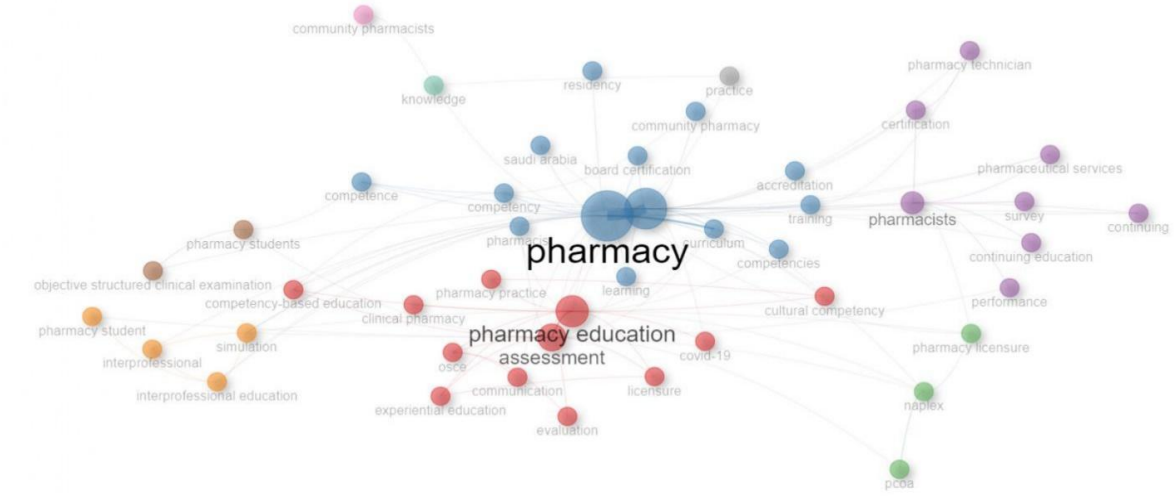

Figure 4. Keywords co-occurrence network

The three-field plot in Biblioshiny visualizes the relationship between keywords, authors, and sources in a bibliometric dataset. This plot aids in understanding the distribution and association of keywords with authors and publication sources. In Figure 5, the left side shows keywords representing the main research topics, the middle section displays authors, and the right side highlights publication sources, such as journals or conferences, to identify key sources in the field.[20]

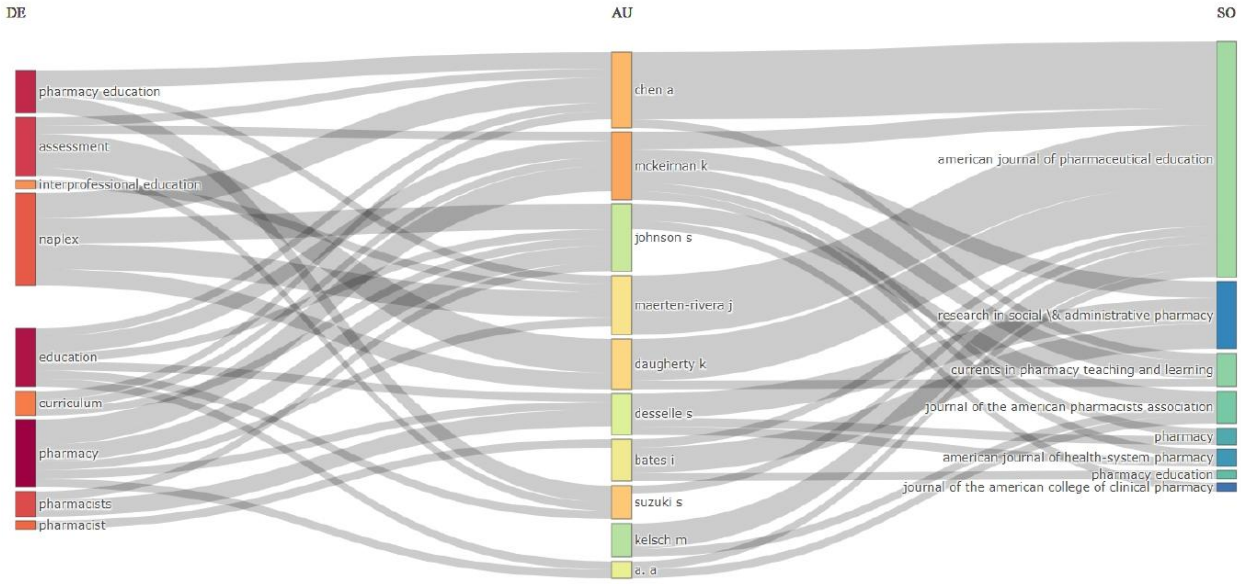

Figure 5. Three-field plot co-authorship

Figure 5 displays a three-field plot showing relationships between keywords, authors, and publication sources in pharmacy education research. On the left, keywords like "pharmacy education," "assessment," and "curriculum" represented key themes. The center highlighted authors such as Chen, Johnson, and Kelsch, indicating their participation levels. Gray lines connecting the three fields showed the relevance between keywords, authors, and sources, with more lines signifying a stronger correlation. For example, the frequent discussion of "interprofessional education" by authors in Currents in Pharmacy Teaching and

Learning illustrated the topic's popularity. This visualization identified key topics, authors, and collaborative networks in pharmacy education research. Key topics included interprofessional education, assessed during the OSCE process, which improves pharmacy practice through better relationships, communication, and care coordination.[42] The analysis also emphasized pharmacists' roles in public health through services like vaccination and chronic disease management, improving safety, treatment outcomes, and community well-being.[43] Moreover, cultural competency was vital in pharmacy, enhancing communication and ensuring patient-centered care, which was underscored by pharmacy education assessments such as the OSCE.[45]

Another topic discussed was the current state of pharmacy education during this research. Pharmacy education focuses on incorporating advanced technologies such as AI to improve learning and assessment. Investigations by Sato & Ogasawara (2024) proposed that AI models such as ChatGPT increased both learning and assessment, urging the incorporation of these technologies for better outcomes and student support.[30] Wang, Shen & Cheng (2023) showed the need for pharmacy curricula to incorporate AI tools, diverse assessments, and humanistic qualities essential for effective healthcare.[33] Following this discussion, Chun et al. (2023) advocated for innovative assessment strategies such as interactive tests to ensure accurate competency measurement and reliable evaluations.[44] Ongoing curriculum updates were also needed to address developing fields including digital health and telepharmacy to ensure that students are prepared for licensure exams. These areas offered significant growth potential, improving education and the quality of future pharmacists.

Network analysis

Bibliographic coupling is a concept where two articles are considered connected when citing the same references. This connection was strengthened as the number of shared references increased. Articles with similar themes were clustered, facilitating the analysis of relationships in a specific field. This method identified clusters, connectivity, and patterns of scientific relationship as well as knowledge dissemination.[21]

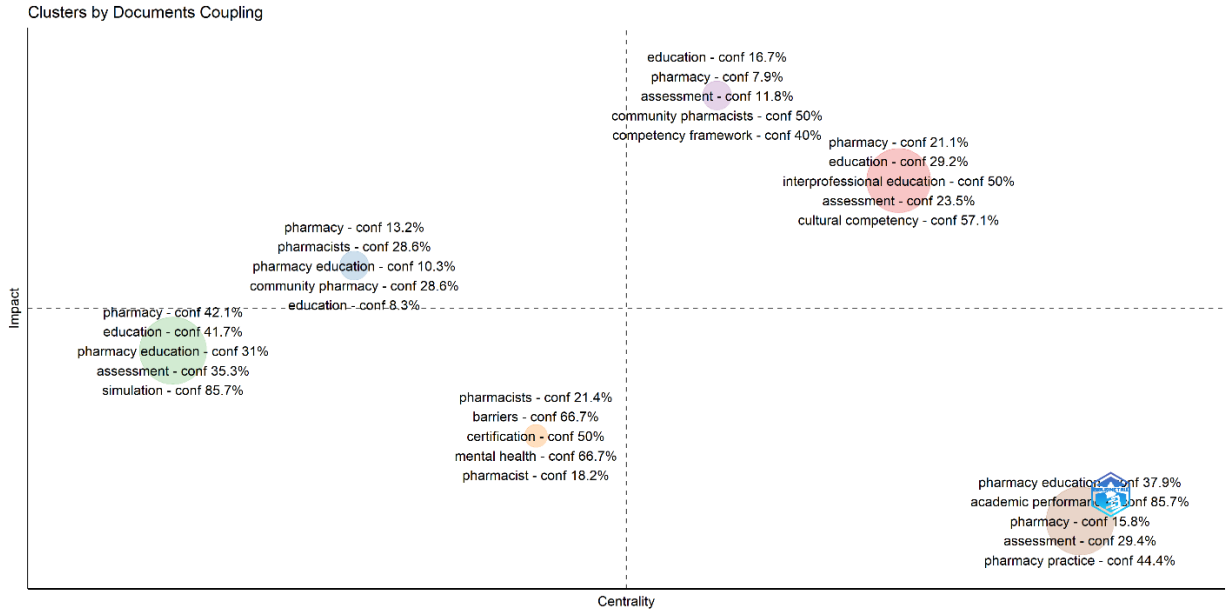

Figure 6. Document Clustering based on bibliographic coupling

Figure 6 shows the cluster distribution based on two dimensions, including impact (vertical axis) and centrality (horizontal axis), where each cluster grouped research themes according to topic interconnections and contribution intensity in the field of pharmacy. The first cluster, located in the top-right quadrant, showed topics such as pharmacy (21.1%), education (29.2%), interprofessional education (50%), assessment (23.5%), and cultural competency (57.1%). This cluster signified the importance of interprofessional education and cultural competence in pharmacy practice, with a centrality of 0.317 as well as an impact of 2.815. The second cluster, which was located at the top center, focused on pharmacy education and the role of pharmacists in society, featuring topics such as pharmacy (13.2%), pharmacists (28.6%), pharmacy education (10.3%), community pharmacy (28.6%), and education (8.3%). This cluster had a centrality of 0.288 and an impact of 2.794, signifying strong thematic connections in pharmacy literature.

The third cluster, located in the bottom-left quadrant, featured topics such as pharmacy (42.1%), education (41.7%), pharmacy education (31%), assessment (35.3%), and simulation (85.7%). This cluster had a centrality of 0.28 and an impact of 2.531, which showed the significance of simulation in pharmacy education, despite having lower centrality than other clusters. Following this discussion, the fourth cluster, situated in the middle-right quadrant, focused on community pharmacists and competency frameworks, featuring topics such as education (16.7%), pharmacy (7.9%), assessment (11.8%), community pharmacists (50%), as well as competency framework (40%). This cluster had a centrality of 0.293 and an impact of 2.865, which signified the importance of measuring competency in community pharmacy practice.

The fifth cluster, located in the center-left quadrant, focused on challenges faced by pharmacists, such as certification barriers and mental health issues. The major topics in this group included pharmacists (21.4%), barriers (66.7%), certification (50%), mental health (66.7%), and pharmacists (18.2%). This cluster had a centrality of 0.289 and an impact of 2.359, addressing specific issues in pharmacists' research. Finally, the sixth cluster,

positioned in the bottom-right quadrant, had the highest centrality of 0.749 and an impact of 1.927. The group focused on academic performance in pharmacy education, with major topics such as pharmacy education (37.9%), academic performance (85.7%), pharmacy (15.8%), assessment (29.4%), and pharmacy practice (44.4%). The cluster served as a central point of discussion due to its strong thematic connections and significant impact on pharmacy education as well as practice.

Based on the Document Clustering shown in Figure 6, various insights were traced, including the positive impact of active learning in medicinal chemistry on student success in licensure exams in North America. Gupta, Smith, and Tromp (2021) found that activities such as research guides, team exercises, and quizzes were moderately correlated with higher scores in the North American Pharmacist Licensure Examination (NAPLEX) as well as the Pharmacy Curriculum Outcomes Assessment (PCOA). These activities improved critical thinking and foundational knowledge, which were essential for exam success while identifying "at-risk students".[40] Similarly, the incorporation of physical exam (PE) instruction into pharmacy curricula supported the goal of preparing pharmacists for success in healthcare. While active learning enhanced theoretical knowledge, PE instruction equipped pharmacists with clinical competencies, such as monitoring therapeutic outcomes and ensuring drug safety, crucial for comprehensive patient care and improved health outcomes.[41]

Outside active learning and PE instruction, addressing broader factors such as academic performance and early interventions was crucial for improving NAPLEX achievement. Success in the NAPLEX exam was influenced by various predictors, including academic performance, Pharmacy College Admission Test (PCAT) scores, Pre-NAPLEX scores, demographic factors, and remediation status. Following this discussion, major interventions to improve pass rates included stratifying students based on risk, early identification of at-risk students, and providing targeted academic support.[24] High failure rates in professional pharmacy programs, particularly for NAPLEX, showed the need for better monitoring and accountability. The proposed two-tiered monitoring system identified programs with higher-than-average failure rates, urging further analysis and improvements.[25] By focusing on these predictors and interventions, pharmacy programs improved student outcomes and increased NAPLEX pass rates.[24]

Pharmacists' competency exam methods

Based on 597 articles from this bibliometric research, several investigations explicitly discussed pharmacists' licensure exam methods in various countries. This information was gathered to review the exam procedures and subject areas tested. The overview of pharmacists' licensure exam methods across different countries is shown in Table 2.

Table 2. An overview of pharmacists' competency exam methods in various countries

No.	Country	Program	Assessment Procedure	Field categories covered in the exam	Related References
1	USA	North American Pharmacist Licensure Examination (NAPLEX)	Clinical (national) and Jurisprudence (state specific). Computer-based test (225 MCQs over 6 hours)[7]	Foundational Knowledge for Pharmacy Practice (25%), Medication Use Process (Prescribing, Transcribing and Documenting, Dispensing, Administering, and Monitoring) (25%), Person-Centered Assessment and Treatment Planning (40%), Professional Practice (5%), Pharmacy Management and Leadership (5%)	Brandon and Romanelli, 2024;[22] Ried et al., 2023;[23] Park, Phillips, and Pavuluri, 2021;[24] Shcherbakova, Pesaturo, and Pezzuto, 2024;[25] Dell et al., 2024;[26] Kane et al., 2023.[27]
2	Canada	Pharmacist Qualifying Examination	Computer-based test (MCQ 4.5 hours) and OSCE (11 stations 7 minutes each station)[7]	Ethical, Legal, and Professional Responsibilities (8%), Patient Care (42%), Product Distribution (13%), Practice Setting (3%), Health Promotion (3%), Knowledge and Research Application (6%), Communication and Education (14%), Intra- and Inter-Professional Collaboration (6%), Quality and Safety (5%)	No related research
3	Saudi Arabia	Saudi Pharmacist Licensure Examination (SPLE)	Computer-based test (300 MCQs 6 hours)[28]	Basic Biomedical Sciences (10%), Pharmaceutical Sciences (35%), Social/ Behavioral/ Administrative Sciences (20%), and Clinical Sciences (35%)[28]	Alghamdi, Almeleebia, and Orayj, 2022;[2] Alghamdi et al., 2024;[29] Chief et al., 2020; Sales et al., 2022.[28]
4	Australia	Intern Written Exam	Computer-based test (75 MCQs 2 hours) and	Practice in applicable legal framework, Develop a patient-centered, culturally	No related research

No.	Country	Program	Assessment Procedure	Field categories covered in the exam	Related References
			oral exam (35 minutes)[7]	responsive method to medication management, Implement the medication management strategy or plan, Monitor and evaluate medication management, Compound medicines, Promote health and well-being.	
5	Japan	Japanese National License Examination for Pharmacists (JNLEP)	Computer-based test (345 MCQs consisting of 90 essential and 255 general questions)[30]	Physics, chemistry, biology, hygiene, pharmacology, pharmaceuticals, pathophysiology, regulations, and practice.[30]	No related research
6	Korea	Korean Pharmacist Licensure Examination (KPLE)	Computer-based test (350 MCQs 325 minutes)[31]	Clinical and practical pharmacy (30%), Biopharmacy (28.6%), Industrial pharmacy (25.7%), Pharmacy legislation (5.7%)[31]	Kim et al., 2017;[31] Park, 2015.[32]

Several investigations from Saudi Arabia discussed the comparison of pass rates for SPLE based on institutions and applicant characteristics, as well as factors that influenced applicant performance and the success of graduates in passing the exam.[29] Similar research in North America, such as the investigations by Brandon and Brown, showed the ongoing issue of declining pass rates for NAPLEX, signaling a growing crisis in many pharmacy schools.[22]

Innovations in exam preparation were also identified in research from Taiwan, which examined the performance of AI models such as ChatGPT in pharmacists' licensure exam.[33] Meanwhile, investigations from Europe and Asia, such as those by Demmer and Kim, explored the implementation of uniform national licensure exams in the medical field as well as attitudes toward the assessment of pharmacy skills in Korean pharmacists' licensure exam.[31,34]

Research from the United States and Indonesia focused on educational aspects that affected exam success, including the admissions process in pharmacy colleges and the first experiences of students with OSCE.[24,35,36] Moreover, investigations from Poland and Australia introduced the use of Objective Structured Practical Examinations (OSPE) and virtual OSCE during the COVID-19 pandemic, showing how pharmacy education adapted to global challenges.[37,38,39]

Other investigations by Gupta and Jones signified the importance of active learning in medicinal chemistry and its correlation with licensure exam success in

North America, as well as the role of PE instruction in US pharmacy curricula.[40,41] Systematic reviews of predictors for NAPLEX success and high failure rates in several professional pharmacy programs further showed the need for increased monitoring of these programs.[24]

DISCUSSION

The bibliometric analysis of pharmacists' competency exams showed significant upward trends, with an average annual growth rate of 11.92% between 2014 and 2024. From the 597 articles analyzed, the United States dominated with 330 articles (55.3%), followed by Canada (31 articles; 5.2%) and Saudi Arabia (28 articles; 4.7%). These publications focused on diverse topics, including OSCE-based assessments, practice-oriented evaluations, and interprofessional relationships. Methods of exams varied across countries, with computer-based tests such as NAPLEX in the United States and OSCE-based assessments in Canada being prominent. Relating to this discussion, Keyword analysis showed "pharmacy" as the dominant theme, closely connected to "pharmacy education" and "interprofessional education." Among the journals analyzed, the American Journal of Pharmaceutical Education led with 93 articles, followed by Currents in Pharmacy Teaching and Learning with 77 articles.

Relationships among authors also played a crucial role in advancing research in pharmacy education. A total of 2,815 authors contributed to this field, with prominent individuals including "MCKEIRNAN K", who published 10 articles with an annual citation rate of 3.20. Additionally, "CHEN A" contributed nine articles with an annual citation rate of 7.00. Visualizations such as the three-field plot showed strong connections between keywords, authors, and journals, with themes such as "interprofessional education" frequently appearing in Currents in Pharmacy Teaching and Learning. Cross-country relationships were particularly significant in Saudi Arabia, which recorded a high MCP rate of 35.7%, compared to just 4.8% in the United States. These relationships significantly strengthened global knowledge networks in pharmacists' education.

The bibliometric findings supported SDGs, particularly Goal 4 on quality education. Innovations such as AI incorporation into OSCE simulations improved the reliability of assessments and promoted adaptive learning methods, ensuring the production of competent pharmacists ready for modern healthcare demands. Moreover, the focus on active learning and competency-based curricula addressed global challenges and contributed to improved public health outcomes. This research showed the strategic importance of bibliometric analysis in designing pharmacy education systems that were inclusive, globally competitive, and responsive to developing needs.

Incorporating PE instruction into pharmacy curricula equipped students with major clinical competencies, such as therapeutic monitoring and medication safety, which were essential for patient-centered care. By adopting active learning models, regular formative assessments, and real-life simulations, pharmacy education programs improved licensure exam pass rates and developed well-rounded pharmacists capable of addressing modern healthcare challenges. This research showed the strategic importance of bibliometric analysis in designing inclusive and globally competitive pharmacy education systems that adapted to developing needs and contributed to public health improvement.

The potential for collaboration among researchers, educators, and practitioners can be explored through various complementary strategies to advance pharmacist competency

assessment methods. Seminars, workshops, and focused discussions serve as platforms for sharing knowledge and experiences, helping to identify weaknesses in current systems and design relevant solutions. [7,46] Approaches such as developing competency frameworks that are both locally and globally relevant using the "adopt and adapt" method encourage the adoption of best practices, while consensus techniques, such as nominal group and Delphi methods, ensure comprehensive and contextual assessments.[47,48]

Global collaboration in education, such as pharmacy residency programs and specialist career pathways at Taipei Medical University, contributes to the design of more effective assessment methods.[49] Cross-border communities of practice further support the exchange of perspectives and experiences to align assessment methods with local needs.[50] Additionally, practice-based collaborations, such as involving community pharmacy technicians, enhance the relevance of local practices while expanding international visibility.[51]

Collaborative projects that facilitate faculty exchange and regional recognition of competency frameworks create opportunities for academic and professional mobility.[52] Finally, the establishment of interprofessional research groups focused on evaluating assessment methods can broaden access to high-impact research, enrich knowledge, and support the sustainable development of pharmacy practices.[53]

The limitations of this research included reliance on data from publicly available publications, which consisted of all internal policies or procedures of the regulatory bodies responsible for administering competency exams. The investigation also used only English-language sources, which introduced publication bias. Additionally, information concerning registration and exam processes in some countries might not fully reflect the latest practices, as many sources did not provide sufficient or up-to-date details.

RECOMMENDATION

Pharmacists' competency development requires integrating theoretical knowledge with practical skills to ensure readiness for independent practice. This goal demands a clear definition of "practice readiness" and collaborative efforts between academics, practitioners, and researchers to establish standardized and globally harmonized competency criteria. Strategies to achieve this include organizing knowledge-sharing platforms, such as seminars and workshops, and leveraging consensus methods like the Delphi method to develop adaptable competency frameworks that align with local regulatory frameworks, healthcare systems, and cultural contexts. Transparency in registration, testing, and evaluation systems further supports the global standardization and quality of pharmacists.

Formal partnerships between educational institutions, regulatory bodies, and international stakeholders are essential for aligning curricula with licensure exam requirements and incorporating innovative evaluation methods, such as AI-driven assessments. Initiatives like pharmacy residency programs, faculty exchanges, and interprofessional research groups promote professional mobility, encourage the adoption of best practices, and foster sustainable pharmacy development. Practice-based collaborations, involving community pharmacy technicians and other local practitioners, enhance the relevance of assessments while expanding international visibility. By strengthening these collaborative efforts and leveraging global relationships, the pharmacist competency

assessment system can reliably evaluate readiness for practice while addressing diverse global and local needs.

CONFLICT OF INTEREST

The authors declared that there were no conflicts of interest associated with this research.

ACKNOWLEDGEMENT

This research was funded by BAZNAS (National Zakat Board of Indonesia) through the 2024 Research Scholarship Program (General Category), based on Letter No. B/4041/DPPD-DPDS/KETUA/KD.02.18/X/2024.

REFERENCES

1. World Health Organization. Global strategy on human resources for health: Workforce 2030 Report by the Director-General. World Health Organization [Internet]. Geneva: World Health Organization. 2022 [Internet]. [Cited 2024 Oct 18]. Available from: https://iris.who.int/handle/10665/252799
2. Alghamdi WA, Almeleebia TM, Orayj KM. Comparison of Saudi Pharmacist Licensure Examination (SPLE) pass rates by institution and applicant characteristics. Healthc. 2022;10(10): 1865. doi: 10.3390/healthcare10101865
3. Kraus S, Breier M, Lim WM, Dabić M, Kumar S, Kanbach D, et al. Literature reviews as independent studies: guidelines for academic practice. Rev Manag Sci. 2022;16(8):2577-95. doi: 10.1007/s11846-022-00588-8
4. Fan D, Zhu CJ, Huang X, Kumar V. Mapping the terrain of international human resource management research over the past fifty years: A bibliographic analysis. J World Bus. 2021;56(2):101185. doi: 10.1016/j.jwb.2020.101185
5. Mukherjee D, Lim WM, Kumar S, Donthu N. Guidelines for advancing theory and practice through bibliometric research. J Bus Res. 2022;148:101-15. doi: 10.1016/j.jbusres.2022.04.042
6. Lim AS, Ling YL, Wilby KJ, Mak V. What's been trending with OSCEs in pharmacy education over the last 20 years? A bibliometric review and content analysis. Curr Pharm Teach Learn. 2024;S1877129723003325. doi: 10.1016/j.cptl.2023.12.028
7. Sheachnasaigh EN, Cadogan C, Strawbridge J, Sahm LJ, Ryan C. A scoping review of the methods and processes used by regulatory bodies to determine pharmacists' readiness for practice. Res Social Adm Pharm. 2022;18(12):4028-37. doi: 10.1016/j.sapharm.2022.06.010
8. Donthu N, Kumar S, Mukherjee D, Pandey N, Lim WM. How to conduct a bibliometric analysis: An overview and guidelines. J Bus Res. 2021;133:285–96. doi: 10.1016/j.jbusres.2021.04.070
9. Zupic I, Čater T. Bibliometric methods in management and organization. Organ Res Methods. 2015;18(3):429–72. doi: 10.1177/1094428114562629
10. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. Br Med J. 2021;n71. doi: 10.1136/bmj.n71
11. Lim WM, Kumar S, Donthu N. How to combine and clean bibliometric data and use bibliometric tools synergistically: Guidelines using metaverse research. J Bus Res. 2024; 182:114760. doi: 10.1016/j.jbusres.2024.114760
12. Aria M, Cuccurullo C. Bibliometrix : An R-tool for comprehensive science mapping analysis. J Informetr.

2017;11(4):959–75. doi: 10.1016/j.joi.2017.08.007
13. Passas I. Bibliometric analysis: The main steps. Encyclopedia. 2024;4(2):1014–25. doi: 10.3390/encyclopedia4020065
14. Büyükkıdık S. A Bibliometric analysis: A tutorial for the bibliometrix package in R using IRT literature. J Meas Eval Educ Psy. 2022;13(3):164-93. doi: 10.21031/epod.1069307
15. Chen J, Lin C, Peng D, Ge H. Fault diagnosis of rotating machinery: A review and bibliometric analysis. IEEE Access. 2020;8:224985–5003. doi: 10.1109/ACCESS.2020.3043743
16. Desselle SP, Mckeirnan KC, Hohmeier KC. Pharmacists ascribing value of technician certification using an organizational behavior framework. Am J Health-Syst Pharm. 2020;77(6):457–65. doi: 10.1093/ajhp/zxz342
17. Chen AMH, Kleppinger EL, Churchwell MD, Rhoney DH. Examining competency-based education through the lens of implementation science: A scoping review. Am J Pharm Educ. 2024;88(2):100633. doi: 10.1016/j.ajpe.2023.100633
18. Suzuki S, Sakurai H, Kawasumi K, Tahara M, Saito S, Endo K. The impact of pharmacist certification on the quality of chemotherapy in Japan. Int J Clin Pharm. 2016;38(5):1326–35. doi: 10.1007/s11096-016-0374-6
19. Misra B, Roy ND, Dey N, Sherratt RS. Visualizing wearable medical device research trends: A co-occurrence network-based bibliometric analysis. Galician Med J. 2023;30(3):E202332. doi: 10.21802/gmj.2023.3.2
20. Rajimol A, George J, Joseph J, Jobin J, Sneha Mk, Beenamole T. Charting new frontiers: Assessing information technology's role in the evolution of image enhancement–A bibliometric approach. J Theor Appl Inf Technol. 2024;102(6):2269-2286.
21. Yun J. Generalization of bibliographic coupling and co-citation using the node split network. J Informetr. 2022;16(2):101291. doi: 10.1016/j.joi.2022.101291
22. Brandon HH, Romanelli F. The North American Pharmacist Licensure Examination (NAPLEX) pass rate conundrum. Am J Pharm Educ. 2024;88(5):100701. doi: 10.1016/j.ajpe.2024.100701
23. Ried LD, Hunter TS, Bos AJ, Ried DB. Association between accreditation era, North American Pharmacist Licensure Examination testing changes, and first-time pass rates. Am J Pharm Educ. 2023;87(3):ajpe8994. doi: 10.5688/ajpe8994
24. Park SK, Phillips J, Pavuluri N. Systematic review of predictors of success for the North American Pharmacist Licensure Examination. Am J Pharm Educ. 2021;85(10):8591. doi: 10.5688/ajpe8591
25. Shcherbakova N, Pesaturo KA, Pezzuto JM. High total failures of the North American Pharmacist Licensure Examination (NAPLEX) warrant monitoring of professional pharmacy programs. Am J Pharm Educ. 2024;88(7):100723. doi: 10.1016/j.ajpe.2024.100723
26. Dell KA, Frankart LM, Ogbonna KC, DiPiro JT. Falling NAPLEX pass rates are cause for concern. Curr Pharm Teach Learn. 2024;16(1):1–4. doi: 10.1016/j.cptl.2023.11.001
27. Kane SP, Luna K, Jacob J, Candelario DM. Frequency of course remediation and the effect on North American Pharmacist Licensure Examination pass rates. Am J Pharm Educ. 2023;87(2):ajpe8894. doi: 10.5688/ajpe8894
28. Sales I, Alwhaibi AM, Aljadeed RI, Alzaidi RF, Shahba A, Almuqbil M, et al. A comprehensive review program to

prepare pharmacy students for the Saudi Pharmacist Licensure Examination (SPLE). Saudi Pharm J. 2022;30(11):1552–60. doi: 10.1016/j.jsps.2022.07.017
29. Alghamdi WA, Almeleebia TM, Almanasef MA, Orayj KM. Factors associated with applicant performance on the Saudi Pharmacist Licensure Examination (SPLE). Saudi Pharm J. 2024;32(5):102044. doi: 10.1016/j.jsps.2024.102044
30. Sato H, Ogasawara K. ChatGPT (GPT-4) passed the Japanese National License Examination for pharmacists in 2022, answering all items including those with diagrams: A descriptive study. J Educ Eval Health Prof. 2024;21:4. doi: 10.3352/jeehp.2024.21.4
31. Kim JH, Lee JY, Lee YS, Yong CS, Han N, Gwak HS, et al. Attitudes to proposed assessment of pharmacy skills in Korean Pharmacist Licensure Examination. J Educ Eval Health Prof. 2017;14:6. doi: 10.3352/jeehp.2017.14.6
32. Park IS. History of the national licensing examination for the health professions under the Japanese government-general of Korea (1910-1945). J Educ Eval Health Prof. 2015;12:21. doi: 10.3352/jeehp.2015.12.21
33. Wang YM, Shen HW, Chen TJ. Performance of ChatGPT on the pharmacist licensing examination in Taiwan. J Chin Med Assoc. 2023;86(7):653-8. doi: 10.1097/JCMA.0000000000000942
34. Demmer I, Selgert L, Altiner A, Baum E, Becker A, Schmittdiel L, et al. Implementation of a uniform nationwide medical licensing examination in general practice. A feasibility study. GMS J Med Educ. 2021;38(5). doi: 10.3205/zma001492
35. Kristina SA, Gustriawanto N, Rokhman MR, Aditama H, Sari IP. Students' first experience with Objective Structured Clinical Examination in a pharmacy school in Indonesia. J Appl Pharm Sci. 2018;8(9):102-6. doi: 10.7324/JAPS.2018.8915
36. Lewing B, Sawant R, Wanat M, Sansgiry SS. Examination of the admissions process and admissions outcomes of a college of pharmacy in the United States of America. Pharm Educ. 2019;19(1):138-145.
37. Kowalski T, Skowron A, Nowakowski M. The role and suitability of the Objective Structured Practical Examination in pharmacy education in Poland. Indian J Pharm Educ Res. 2019;53(2):186-91. doi: 10.5530/ijper.53.2.24
38. Dymek J, Kowalski T, Golda A, Polak W, Skowron A. The first Objective Structured Practical Examination (OSPE) in pharmacy teaching in Poland: Designing, implementing and assessing the results. Int J Pharm Educ Res. 2020;54(3):574-80. doi: 10.5530/ijper.54.3.106
39. Mak V, Krishnan S, Chuang S. Students' and Examiners' experiences of their first virtual pharmacy Objective Structured Clinical Examination (OSCE) in Australia during the COVID-19 Pandemic. Healthcare. 2022;10(2):328. doi: 10.3390/healthcare10020328
40. Gupta D, Smith MM, Tromp K. Utilization of active learning approaches in medicinal chemistry and subsequent correlations with North American Licensure Examination and Pharmacy Curriculum Outcomes Assessment scores. Curr Pharm Teach Learn. 2021;13(4):376–81. doi: 10.1016/j.cptl.2020.11.002
41. Jones M, Gokun Y, Cain J, Romanelli F. Physical examination instruction in US pharmacy curricula. Curr Pharm Teach Learn. 2014;6(3):340–7. doi: 10.1016/j.cptl.2014.02.013
42. Doloresco F, Maerten-Rivera J, Zhao Y, Foltz-Ramos K, Fusco NM.

Pharmacy Students' Standardized Self-Assessment of Interprofessional Skills During an Objective Structured Clinical Examination. Am J Pharm Educ. 2019;83(10):7439. doi: 10.5688/ajpe7439
43. Lim A, Krishnan S, Singh H, Furletti S, Sarkar M, Stewart D, et al. Linking assessment to real life practice – comparing work based assessments and objective structured clinical examinations using mystery shopping. Adv in Health Sci Educ. 2024;29(3): 859–78. doi: 10.1007/s10459-023-10284-1
44. Chun KH, Jin HK, Yoon JH, Kim MG, Choi KH, Kim E, et al. Novel innovative computer-based test (Inno-CBT) item types for national licensing examinations for health care professionals. BMC Med Educ. 2023;23(1):560. doi: 10.1186/s12909-023-04444-5
45. Shelton CM, Metcalfe A, Spivey C, Renfro CP, Schoelles J. Comparison of student performance in therapeutics and communications courses to outcomes of objective structured clinical examinations: A retrospective analysis. Curr Pharm Teach Learn. 2022;14(3): 290–7. doi: 10.1016/j.cptl.2022.01.007
46. McMullen J, Arakawa N, Anderson C, Pattison L, McGrath S. A systematic review of contemporary competency-based education and training for pharmacy practitioners and students. Res Social Adm Pharm. 2023;19(2): 192–217. doi: 10.1016/j.sapharm.2022.09.013
47. Meilianti S, Smith F, Bader L, Himawan R, Bates I. Competency-Based Education: Developing an Advanced Competency Framework for Indonesian Pharmacists. Front Med. 2021;8:769326. doi: 10.3389/fmed.2021.769326
48. Alfaifi S, Bridges S, Arakawa N. Developing pharmacists' competencies in Saudi Arabia: A proposed national competency framework to support initial education and professional development. Curr Pharm Teach Learn. 2022;14(10):1256–68. doi: 10.1016/j.cptl.2022.09.010
49. Prescott GM, Jonkman L, Crutchley RD, Dey S, Hong LT, Malhotra J, et al. Characteristics of Successful International Pharmacy Partnerships. Pharm. 2023;11(1):7. doi: 10.3390/pharmacy11010007
50. Zamiri M, Esmaeili A. Methods and Technologies for Supporting Knowledge Sharing within Learning Communities: A Systematic Literature Review. Adm Sci. 2024;14(1):17. doi: 10.3390/admsci14010017
51. Burghle A, Hansen R, Nørgaard L, Hedegaard U, Bendixen S, Søndergaard L, et al. The Danish Network for Community Pharmacy Practice Research and Development. Pharm. 2021;9(2):114. doi: 10.3390/pharmacy9020114
52. Etukakpan A, Uzman N, Ozer O, Tofade T, Leite SN, Joda A, et al. Transforming pharmaceutical education: A needs-based global analysis for policy development. Explor Res Clin Soc Pharm. 2023;9:100234. doi: 10.1016/j.rcsop.2023.100234
53. Badowski M, Mazur JE, Lam SW, Miyares M, Schulz L, Michienzi S. Engaging in Collaborative Research: Focus on the Pharmacy Practitioner. Hosp Pharm. 2017;52(1):33–43. doi: 10.1310/hpj5201-33