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A Bibliometric Analysis of the Knowledge Structure of Reflective Learning in the Health Sciences**

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ABSTRACT

This research aims to identify the developmental patterns of reflective learning in the health sciences context and offer suggestions for future research in this field. Our dataset consists of 385 studies conducted between 1983 and 2023 in the Web of Sciences (WOS) database. In this study, bibliometric analysis techniques such as performance analyses, co-citation analysis, co-word analysis, and co-authorship analysis were employed. The results of the co-word analysis indicated that Cluster 1 emphasizes medical education, student performance, and skill development, showcasing that self-assessment and feedback are crucial components of reflective learning. Cluster 2 explores how health services shape student experiences and the impact of reflective learning on these experiences. Cluster 3 highlights the centrality of reflective learning in professional development and patient interaction. Clusters 4 and 5 elucidate the roles of knowledge, attitudes, and quality management in the reflective learning process. Clusters 6 and 7 underscore the critical importance of continuous improvement and patient safety within the context of reflective learning. In conclusion, the topic of reflective learning is garnering increasing interest in health disciplines, and further comprehensive analyses are needed to better understand the trend of this interest.

Keywords: Reflective learning, health, bibliometric analysis

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Sağlık Bilimlerinde Yansıtıcı Öğrenmenin Bilgi Yapısının Bibliyometrik Analizi

ÖZ

Bu araştırma, sağlık bilimleri bağlamında yansıtıcı öğrenmenin gelişim örüntülerini belirlemeyi ve bu alanda gelecekte yapılacak araştırmalar için öneriler sunmayı amaçlamaktadır. Veri setimiz Web of Sciences (WOS) veri tabanında 1983-2023 yılları arasında yapılmış 385 çalışmadan oluşmaktadır. Bu çalışmada performans analizi, ortak atıf analizi, ortak kelime analizi ve ortak yazarlık analizi gibi bibliyometrik analiz teknikleri kullanılmıştır. Ortak kelime analizinin sonuçları, Küme 1'in tıp eğitimi, öğrenci performansı ve beceri gelişimini vurguladığını, öz değerlendirme ve geri bildirimin yansıtıcı öğrenmenin önemli bileşenleri olduğunu göstermiştir. Küme 2, sağlık hizmetlerinin öğrenci deneyimlerini nasıl şekillendirdiğini ve yansıtıcı öğrenmenin bu deneyimler üzerindeki etkisini araştırmaktadır. Küme 3, mesleki gelişim ve hasta etkileşiminde yansıtıcı öğrenmenin merkeziliğini vurgular. Küme 4 ve 5, yansıtıcı öğrenme sürecinde bilgi, tutum ve kalite yönetiminin rollerini açıklamaktadır. Küme 6 ve 7, yansıtıcı öğrenme bağlamında sürekli iyileştirme ve hasta güvenliğinin kritik öneminin altını çizmektedir. Sonuç olarak, yansıtıcı öğrenme konusu sağlık disiplinlerinde giderek artan bir ilgi görmektedir ve bu ilginin eğilimini daha iyi anlamak için daha kapsamlı analizlere ihtiyaç vardır.

Anahtar Kelimeler: Reflektif öğrenme, sağlık, bibliyometrik analiz

1 Introduction

Reflective learning holds critical importance in health professionals' education, enhancing learners' capacity to learn from experiences and continually improve professional practice. Reflective learning is a process triggered by an experience, in which an individual internally examines and discovers a concern, creating meaning from their own perspective, clarifying, and resulting in a change in conceptual outlook [1, 2]. The reflective learning process can be examined in three stages: returning to the experience, dealing with emotions, and the processing stage. In the first stage, returning to the experience, students recall events and re-examine their reactions to those events. In the second stage, dealing with emotions, it enhances the student's self-awareness and helps to maintain their positive emotions while discarding the negative ones. In the final stage, the processing stage, events are interpreted and restructured by the student [3].

We believe that studying reflective learning in health sciences will have significant implications. Firstly, this concept is central to the education of professional groups in health sciences, such as medicine, nursing, and midwifery [1]. Therefore, the findings from analysing a dataset spanning forty years hold the potential to improve educational strategies and professional practices, ultimately contributing to better health outcomes in the health sciences. Secondly, this research highlights the importance of reflective learning in developing the knowledge, attitudes, and competencies necessary for quality management and continuous improvement in healthcare services [4]. Lastly, the study provides invaluable insights into academic outcomes and the effects on professional development and patient interactions, demonstrating that reflective learning is not just about academic results but also plays a crucial role in the broader context of healthcare practice and patient care [5, 6].

In this context, several studies examine reflective learning in health sciences. A systematic review by Mann, Gordon, and MacLeod (2009) highlighted the increasing importance of reflection in health sciences education. [1]. The work of Braun and Clarke (2006) on using thematic analysis in psychology aids in identifying themes that support the reflective learning process, enabling an in-depth analysis of student experiences within this process [7]. The main themes supporting the reflective learning process are self-Assessment and Awareness, Critical Thinking, Analysis of Errors and Successes, Personal and

Professional Development, Feedback and Communication, Effective Learning Strategies, the Role of the Educator, and Emotional Processing. The theme of Self-Assessment and Awareness encourages students to evaluate their learning processes and behaviours, enhancing their self-awareness and self-reflection skills.

Sandars (2009) and Boyd and Fales (1983), who address the use of reflective learning in medical education, emphasize the importance of this process, while Boud and Walker (1998) and de Rome et al. (1985) have drawn attention to the current challenges in promoting reflective learning in professional courses [8-11]. The work of Wong and Colleagues (1995) on reflective journals stands out as a significant tool in assessing students' levels of reflection [12]. Epstein (1999) and Epstein and Hundert (2002) have highlighted the importance of reflective practices in defining and evaluating mindfulness and professional competence [13, 14].

Gibbs (1988), who developed the 'learning by doing' approach, emphasizes the role of concrete experiences in developing reflective practices, while Pee and colleagues (2002) have pointed to the importance of using a structured worksheet in assessing students' written reflections [15, 16]. Aronson (2011) offered practical tips for teaching reflective learning at medical education levels, and Driessen et al. (2007), along with Sobral (2000), addressed the importance of evaluating students' learning achievements, self-confidence, and diagnostic abilities [5, 6, 17]. Wald and Reis (2010) focused on reflective writing and the development of reflective capacity, highlighting the critical importance of individuals' beliefs in their abilities in this process through Bandura's (1977) self-efficacy theory [18, 19]. Buckley and colleagues (2009) have presented a systematic review of the educational impact of portfolios on student learning [20]. This study on the educational effects of reflective journals and formative feedback emphasizes the importance of these methods in helping students understand and improve their involvement in learning processes. Dividing reflective practices into five categories has assisted students in enhancing the quality of these practices, and it has been observed that the quality of teacher-student relationships plays a significant role in this process. The research demonstrates that formative feedback contributes to students thinking more deeply, adding more meaning to their learning experiences. These results show the value of effectively using reflective practices and feedback in education [21]. The study conducted by MacAskill and colleagues (2023) thoroughly examines the diversity of reflective learning methodologies in medical education and how these methodologies contribute to the holistic development of students. Findings reveal that creative, reflective learning approaches significantly benefit recognizing multiple perspectives among students, fostering empathy, developing bilateral communication skills, and patient-centered care themes [22].

Considering these studies, it is evident that reflective learning has found a wide application in health education and the healthcare field. Consequently, some studies have examined the developmental patterns in the literature. These studies have been limited to topics in health education such as healthcare education [23], health profession education [1], and medical education [4] with no research presenting a holistic view of the field's development patterns. This research aims to identify the developmental patterns of reflective learning in the health sciences context and offer suggestions for future research in this field. The research seeks answers to several questions: i) Who are the most influential authors, journals, institutions, and countries in developing the reflective learning literature in the health field? ii) What are the emerging trend topics in reflective learning in the health field? iii) What developmental trends do the patterns of co-citation, co-authorship, and co-occurrence of terms in reflective learning in the health field show? In this context, the study contributes in two ways. Firstly, we provide a holistic perspective on the development patterns of reflective learning in health, offering insights that can guide scientists and students interested in the area. The presentation of the most influential sources, authors, journals, countries, and institutions mainly serves as a ready resource for those wishing to work in this field. Secondly, by showcasing the change patterns in the field, we provide information on which

concepts have emerged and receded, thus setting a roadmap for future research. The second part of the research presents the methodology section. The third part is dedicated to the findings of the research. Finally, the study is completed with the discussion and conclusion section.

2 Methodology

This research utilized bibliometric analysis techniques such as performance analyses, co-citation analyses, co-word analyses, and co-authorship analyses [24, 25]. The data for the research were obtained from the Web of Sciences (WoS) database. This database was chosen because it is widely used among management scientists and is considered the most influential database in the scientific community [26-30]. The data for the study were extracted from the database using the following search strategy. *Search strategy:* "reflective learning" (Topic) and Health Care Sciences Services or Nursing or Medicine General Internal or Psychology Multidisciplinary or Public Environmental Occupational Health or Psychology Educational or Dentistry Oral Surgery Medicine or Psychiatry or Primary Health Care or Health Policy Services or Psychology Applied or Pharmacology Pharmacy or Psychology Social or Rehabilitation or Ergonomics or Surgery or Dermatology or Clinical Neurology or Cardiac Cardiovascular Systems or Audiology Speech Language Pathology or Respiratory System or Obstetrics Gynecology or Anesthesiology or Psychology Developmental or Psychology Clinical or Psychology or Pediatrics or Neurosciences or Critical Care Medicine or Medicine Research Experimental or Medical Informatics or Emergency Medicine or Radiology Nuclear Medicine Medical Imaging or Psychology Experimental or Gerontology or Nutrition Dietetics or Oncology or Ophthalmology or Anatomy Morphology or Gastroenterology Hepatology or Geriatrics Gerontology or Medical Ethics or Psychology Psychoanalysis (Web of Science Categories) and News Item or Correction or Book Review or Letter or Meeting Abstract or Book Chapters or Proceeding Paper or Editorial Material (Exclude – Document Types)". After the data were extracted, analyses were conducted using Bibliometrix software. In the following section, the purpose of each analysis is explained, and the data obtained as a result of these analyses are presented.

3 Results

The findings are divided into two parts: performance analyses and scientific mapping analyses. The performance analyses included vital information, such as the number of publications and citations per year, the most prolific institution, author, country, and journals, and an analysis of trending topics. In the scientific mapping analyses, co-citation, co-occurrence, and co-author analyses were performed.

3.1 Performance Analysis

Performance analysis allows to identify the contribution of research components to a specific field [24]. The Figure 1 includes 385 documents focusing on 'reflective learning' in health disciplines between 1983 and 2023. The annual growth rate is observed to be 8.87%. This indicates that reflective learning is an emerging area of interest in health disciplines. The majority of the documents are articles (350), along with early access articles (6) and review articles (28). This shows that the bulk of the work in this area consists of original research. The small number of review articles may imply that the field is not yet consolidated.

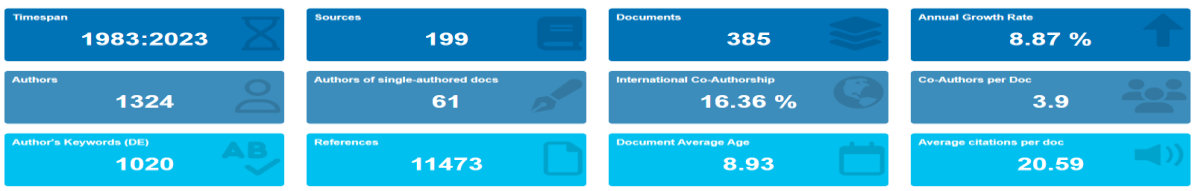

Figure 1: *Data Statistics*

The average number of citations per document is 20.59, which indicates the topic's significance and impact. With an average of 3.9 authors per document and 16.36% international collaboration, it can be said that there is a multidisciplinary and international approach in this field. Particularly in terms of health disciplines, these collaborations can be quite valuable. The abundance of keywords (1020) and Keywords Plus (659) indicates that the topic is addressed in various aspects. This suggests that reflective learning may have different applications and theoretical frameworks for health disciplines.

Figure 2 highlights the following elements: The number of publications has generally increased since 1983, with a notable rise after 2010. The highest number of publications was in 2023 (30 publications). Citation numbers have not been entirely correlated with the number of publications. For example, while 1204 citations were received in 2015, there were 23 publications in the same year. However, in 2021, 29 publications received only 77 citations. Recent Years: In the most recent years (2021-2023), the total number of citations has been relatively low despite the increase in publications. This may be due to the publications being more recent.

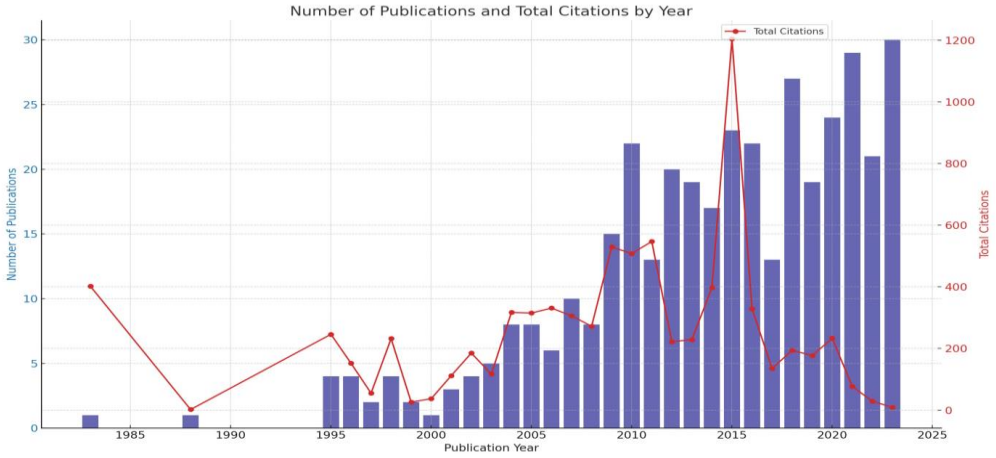

Figure 2: *Number of Publications and Citations by Years*

Table 1 lists the top 10 most cited articles. Upon detailed examination of the first four articles, we observe that some studies present a model of being aware of one's reflective learning styles and consciously choosing to use these styles [9]. Additionally, another study has defined an integrated conceptual framework named 'PEARLS' to foster excellence and reflective learning within the simulation [31]. Another research highlights the positive effects of general learning and specifically reflective learning styles on academic performance [32]. Yet another study has designed research from the perspective of the Iterative Reprocessing (IR) model, finding that a short-term intervention targeting reflection and rule use led to enhanced cognitive functionality, theory of mind, and corresponding changes in brain functions [33].

Table 1: *The 10 Most Cited Articles*

Articles	Total Citations	TC per Year	Normalized TC
Boyd EM, 1983, J Humanist Psychol	402	9,8	1
Eppich W, 2015, Simul Healthc	396	44	7,56
Komarraju M, 2011, Pers Indiv Differ	319	24,54	7,58
Zelazo Pd, 2015, Dev Rev	232	25,78	4,43
Wong FKY, 1995, J Adv Nurs	215	7,41	3,5
Joy S, 2009, Int J Intercult Rel	203	13,53	5,76
Wald HS, 2015, Acad Med	175	19,44	3,34
Kumagai AK, 2008, Acad Med	154	9,63	4,53
Lachman N, 2006, Clin Anat	154	8,56	2,79
Snadden D, 1998, Med Teach	129	4,96	2,22

Table 2 displays the publishing sources, institutions, regions, and authors that utilize reflective learning within the context of health sciences. Publishing Sources: It shows the journals that have published the most articles on reflective learning in health sciences. Institutions indicate how productive different academic institutions or universities are in this field. Regional frequency demonstrates the contributions of other regions to reflective learning. Productivity of authors shows the authors who have written the most articles and their publication counts. From this table, we can see that 'Medical Teacher' and 'Nurse Education Today' are among the leading journals in the field of health education, with 22 and 20 articles, respectively. These journals can be considered as one of the most significant sources in the field of health education. Among the most published universities are 'The University of Calgary,' 'The University of Ottawa,' and 'Maastricht University'.

Table 2: *Institutions, Authors, Countries and Journals with the Most Publications*

Journals	Articles	Institutions	Articles	Country	Frequency	Authors	Frequency
Medical Teacher	22	University of Calgary	18	USA	226	Eppich W	5
Nurse Education Today	20	University of Ottawa	18	UK	200	Branch WT	4
Medical Education	16	Maastricht University	12	Canada	130	Cheng A	4
Nurse Education in Practice	11	McGill University	12	Australia	120	Vachon B	4
Clinical Simulation in Nursing	9	University of Birmingham	9	China	49	Bion J	3
Journal of Advanced Nursing	8	University of California System	9	Netherlands	45	Bowie P	3
Journal of Dental Education	7	University of London	9	Spain	31	Brand G	3
Journal of Nursing Education	7	University of Melbourne	9	Germany	22	Chandrasekaran B	3
American Journal of Pharmaceutical Education	6	University of Toronto	9	South Africa	21	Chien WT	3
Journal of Continuing Education in the Health Professions	6	Feinberg School of Medicine	8	Sweden	21	Cress U	3

These universities are ranked in the top three with 18, 18, and 12 articles, respectively. It can be said that these universities play a significant role in the field of health education. The countries publishing the most are the 'USA,' 'UK,' and 'Canada.' These countries are ranked in the top three with 226, 200, and 130 frequencies, respectively. It can be stated that these countries are leaders in the field of health education. The most prolific authors include 'Eppich W,' 'Branch WT,' and 'Cheng A.' These are ranked in the top three with 5, 4, and 4 publications, respectively. These authors may have made significant contributions to the field of health education. This table indicates which institutions, countries, and authors are the most active in health education. This information can be a valuable resource for those who wish to conduct research in the field of health education.

3.2 Analysis of Trending (Prominent) Topics

When analysing Figure 3, several key findings emerge. The concepts of 'Reflection' and 'Reflective learning' are quite popular in health sciences, with frequencies of 39 and 65, respectively. On the other hand, concepts like 'Quality improvement' and 'Collaborative learning' are mentioned only five times, indicating less attention to these topics. General educational concepts like 'Learning' and 'medical education' have consistently evolved since older dates. They are mainly concentrated between the years 2006-2010. Concepts like 'Nursing' and 'training' have recently gained popularity, with median years close to 2021 and 2022. There is an imbalance between general concepts ('learning,' 'education') and more specific concepts ('nursing education,' 'experiential learning'). Specific concepts seem to have become popular more recently. There is a substantial body of literature on reflective learning ('reflection,' 'reflective practice,' 'reflective learning') with a trend that varies over time. Notably, 'reflective learning' has gained popularity since 2015.

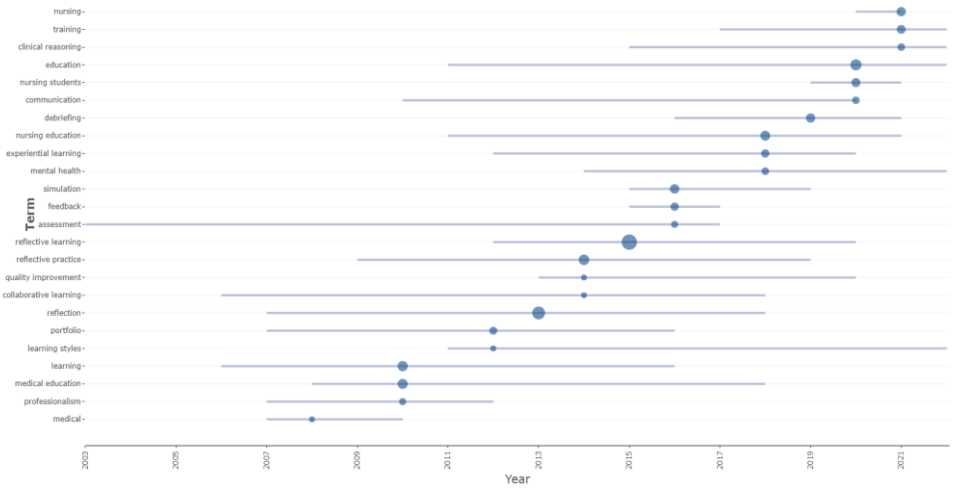

Figure 3: *Changes in Conceptual Patterns*

These findings indicate that reflective learning is significant in health sciences education. However, other areas in this field require attention; for instance, areas like 'quality improvement' or 'collaborative learning' may need more research and focus. Furthermore, reflective learning has evolved into more specific sub-topics (for example, 'reflective practice' or 'debriefing'). This suggests that we may need a more comprehensive understanding of how students and professionals can use different forms of reflection in their educational processes.

When examining the word cloud in Figure 4, it is observed that terms related to reflective learning and reflection are used more frequently in the context of health sciences. Alongside these terms, words such as education, reflective practice, medical education, and learning are used less frequently. Other terms like nursing education, informatics, simulation, nursing students, training, nursing, portfolio feedback, experiential learning, qualitative research, clinical reasoning, and mental health are also present but used much less frequently in health sciences.

Figure 4: *Word Cloud Analysis*

3.3 Science Mapping

Science mapping allows visualization of network relationships between research components. Different techniques exist, such as citation analysis, co-citation analysis, bibliography matching, common word analysis, and co-authorship analysis [28]. In this study, a review was conducted using co-citation analysis, co-word analysis, and co-authorship analysis techniques.

3.3.1 Co-Citation Analysis

Co-citation is the frequency with which two documents are cited together [34]. Co-citation analysis is used to create measures of similarity among documents, authors, or journals [30]. Üsdiken and Pasadeos (1995) have indicated that after all citations in a specific document are recorded, a list of all pairs of works cited in that document can be obtained, and by repeating this procedure for a large number of documents, frequencies of co-citations can be generated. In this case, a co-citation network is formed [35]. The co-citation network is represented by a line when multiple different documents cite two papers together. The strength of a co-citation depends on the number of sources citing both documents and is represented by the number or size of lines connecting the two papers [36]. Co-citation analysis can identify the most influential publications in a field [37]. The more citations two documents receive, the more similar their contents are considered to be [38].

Bibliography coupling refers to the similarity of the bibliographies of two different studies. [39]. However, mapping science frequently uses Co-citation Analysis [30]. Bibliographic coupling is considered a static analysis because it relies on the references in the related documents. In contrast, co-citation analysis is dynamic as it changes over time [38]. When two documents receive a high rate of citations, co-citation analysis can reveal which of these documents is considered more important by the researchers citing them. However, in bibliographic coupling, it is difficult to determine which document is more significant. This is both a strength and a weakness of co-citation analysis. While it contains high information for highly cited documents, it is unreliable for less cited niche expertise areas [30].

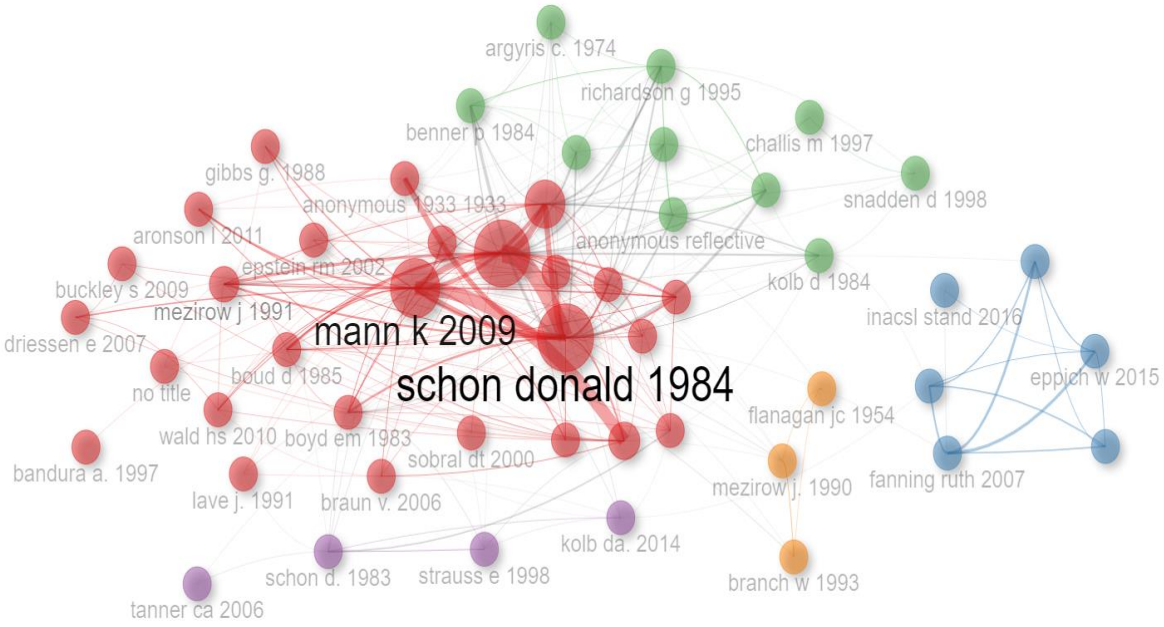

Figure 5: *Co-Citation Analysis Network Structure*

For the red cluster, Cluster 1, the theme will be 'Reflective Learning Processes and Practices.' The reason for selecting this theme is that the studies in Cluster 1 comprehensively examine how reflective learning is used in the education of health professionals and the impact of this process on student success, self-confidence, and professional competence.

Mann, Gordon, and MacLeod's (2009) study emphasizes the importance and effectiveness of reflective practices in health sciences education by presenting a broad literature review [1]. Braun and Clarke (2006) demonstrate the role of reflective thinking in interpreting qualitative data using thematic analysis [7]. Sandars' (2009) study provides a comprehensive guide on how reflective learning can be used in medical education [8]. Boyd and Fales (1983) discuss the critical role of reflective learning in the process of learning from experiences, while Boud and Walker (1998) and De Rome et al. (1985) address the challenges of promoting reflective learning in professional courses and changes in academic staff's perceptions of teaching and research [9-11]. Wong and colleagues' (1995) study presents a method for assessing the level of student reflections, and Epstein's (1999, 2002) works focus on mindful practices and the definition of professional competencies of health professionals [12-14]. The works of Gibbs (1988) and Pee et al. (2002) contribute to learning methodologies and the evaluation of student reflections [15, 16], while Aronson (2011) and the studies of Driessen et al. (2007) discuss methods of teaching reflective learning in medical education and the complex success of portfolios [5, 6]. Sobral (2000) and Wald and Reis (2010) focus on the assessment of students' diagnostic abilities and the development of reflective capacity in medical education [17, 18]. Lastly, Bandura's (1977) self-efficacy theory and the study of Buckley and colleagues (2009) on the educational effects of portfolios are significant components of this theme [19, 20]. These articles provide an in-depth look into how reflective learning can be integrated into health education, contribute to student development, and enhance professional competencies.

When examining the blue Cluster 2, we can see that the common theme of the articles in this group is 'Reflective Learning with Debriefing in Health Simulations.' This theme encompasses debriefing methods focused on enhancing learning and performance in the simulation-based learning process in health education. In health simulation training, debriefing refers to the process where students or professionals analyse the simulated scenarios they experience, reflect on their experiences, and integrate

what they have learned. Fanning and Gaba's (2007) study highlight the role of debriefing in simulation-based learning. This study reveals the importance of feedback in health simulations and how debriefing plays a critical role in the learning process [40]. Eppich and Cheng (2015) present the development and rationale of a blended approach named PEARLS, which is designed for use in healthcare simulation debriefing. This approach is a debriefing model that encourages learning and reflective thinking [31]. Rudolph et al.'s 2006 study discusses how collaborative offline reflection can be used to develop action science and inquiry skills. This demonstrates how the debriefing process can be effective in post-simulation and general health education [41]. Rudolph and colleagues' subsequent studies in 2007 and 2008 examined using debriefing as a formative assessment and how it can bridge performance gaps in medical education. These studies show how the debriefing process can be integrated with critical thinking and authentic inquiry [42, 43]. The common thread of these articles is the importance of debriefing processes in health simulations and how these processes can contribute to reflective learning. These works lay the foundation for developing and enhancing debriefing techniques in simulation-based training.

The green Cluster 3 focuses on 'Overall Reflective Learning.' This theme is based on reflections on how students and health professionals learn from their experiences and apply this learning in practice. Richardson and Maltby (1995) examine how students' reflections on their practices enhance their learning. This study shows how reflective learning helps students draw lessons from their experiences [44]. Atkins and Murphy (1993) review the existing literature on reflective practice and emphasize its significant role in student and practitioner professional development [45]. Johns (1995) discusses how reflective learning can be framed in nursing through Carper's Ways of Knowing. This work addresses the importance and application of reflective thinking in nursing education [46]. Powell (1989) investigates how reflective practice is implemented in nursing, highlighting the importance of reflection in professional practice [47]. Argyris and Schön (1974) address the relationship between theory and practice to enhance the effectiveness of professionals. Their work provides the theoretical foundations for reflective thinking [48]. Snadden and Thomas (1998) and Challis et al. (1997) explore the effectiveness of portfolio-based learning in general practitioner training and how this form of learning integrates with reflective practice. Portfolio-based learning is an educational approach where students or professionals create a portfolio to document their knowledge, skills, experiences, and personal development. This method, prevalent in health sciences and education fields, involves portfolios typically comprising various materials such as written work, projects, research, self-assessment, reflective writings, and practical experiences. These studies demonstrate the applicability and impact of reflective learning in professional education [49, 50]. These articles underscore the importance of reflective learning in health education and professional development, providing valuable insights into implementing reflective practices in nursing and general practitioner training. Together, under the theme of 'Reflective Learning,' these works highlight the significance of continuous learning and development in the education and practice of health professionals.

Based on the co-citation analysis data on reflective learning, the orange Cluster 4 can be named 'Dynamics of Reflective Practice in Professional Development.' This theme focuses on the deep, reflective processes professionals use in their practice and learning, encapsulating the essence of these works. Kolb et al. (2014) emphasize the importance of experiences in professionals' learning processes by addressing previous research and new directions in experiential learning theory. This study lays the groundwork for reflective learning, enabling individuals to enhance their ability to learn from personal experiences [51]. Schon (1983) explores how professionals think in action, highlighting the significance of reflective practice. This work focuses on developing professionals' abilities to analyze situations they encounter and learn from them [52]. Boud (2001) focuses on using journal writing to develop reflective practice. This approach plays a significant role in professional development by enabling individuals to

express their experiences in writing and engage in deep thinking during this process [53]. Lastly, Tanner (2006) presents a research-based model used in clinical judgment in nursing, emphasizing the role of reflective thinking in professionals' decision-making processes. This model demonstrates the importance of reflective thinking in complex decision-making situations and provides essential insights into how professionals can develop these skills [54]. These works deeply examine the role of reflective practice in professional development, clarifying the scope and significance of this theme.

The purple Cluster 5 has been named 'Critical Incident Technique and Transformation in Adult Education in the Reflective Learning Process.' This theme emphasizes the examination of critical incidents in the learning process and the importance of transformative approaches in adult education. Flanagan's (1954) work on the 'Critical Incident Technique' profoundly examines the process of learning from individuals' experiences and how this process is shaped by critical incidents [55]. Flanagan's study lays the foundations for reflective learning, contributing to analysing individuals' experiences and enhancing their ability to learn from these experiences. Mezirow (1990) developed the theory of transformative learning in adult education. This theory describes reaching knowledge by questioning individuals' experiences and assumptions [56]. Mezirow's work further deepens the role of critical incidents in the reflective learning process, enabling individuals to undergo significant personal and professional transformations. The study by Branch et al. (1993) examines the vital incidents encountered by third-year medical students and investigates their impact on the students' process of becoming doctors [57]. This study demonstrates how reflective learning can be applied in professional education and reveals how students can learn and practice more effectively in the face of critical incidents.

3.3.2 Co-occurence Analysis

Co-occurrence is used to provide a visual representation of a scientific field's structure and examine relationships between authors or journals. When direct similarity is applied to co-occurrence data, the aim is to normalize the data, that is, to correct for differences in the total number of occurrences or co-occurrences of objects [58]. This method summarizes the weighted inputs from the entire visual [59]. Thus, this analysis allows for determining the dynamics of science without any predefined definition of research themes [60]. Türkmendağ (2021) has noted the importance of this analysis in visualizing the literatüre [61]. Furthermore, Lis (2018) has stated that the clustering of keywords manually performed by authors would be highly subjective and flawed [62].

Based on the results of the co-occurrence analysis, the identified theme names and evaluations for each cluster within the context of health sciences and reflective learning indicate the existence of seven clusters. Cluster 1, colored red, has been named 'Education and Assessment.' The concepts in this cluster include medical education, model, performance, feedback, skills, competence, portfolios, self-assessment, science, nursing students, tools, behaviour, and confidence. This cluster encompasses fundamental concepts related to medical education and student performance. Concepts such as 'feedback' and 'self-assessment' represent the self-evaluation and feedback dimensions of reflective learning.

Cluster 2, colored blue, is grouped under 'Healthcare Services and Student Experience.' The key concepts in this cluster are education, students, care, experiences, perceptions, nurses, curriculum, healthcare service, impact, outcomes, thought, health, simulation, strategies, knowledge, self-reflection, stress, children, and internship. This cluster emphasizes how healthcare services shape students' experiences and perceptions, how this process can affect student care, and the importance of self-reflection. Concepts such as 'experiences,' 'perceptions,' and 'self-reflection' illustrate how reflective learning can enrich student experiences and highlight the role of this process in individual development.

Cluster 3, colored green, is named 'Professionalism and Patient Interaction.' The prominent critical concepts in this cluster are reflection, professionalism, and patience. This cluster emphasizes the interaction of health professionals with patients and how this interaction is shaped within the framework of professionalism. The concept of 'reflection' emerges as a critical component of reflective learning that supports professional development and strengthens patient interaction. In this context, how reflection can be integrated into professional practice to improve patient interactions is considered a significant topic.

Purple Cluster 4: 'Knowledge and Attitudes': The key concepts in this cluster can be listed as knowledge, program, attitudes, validity, and capacity. This cluster highlights the critical importance of knowledge and attitudes in the reflective learning process. The concepts of 'knowledge' and 'attitudes' are fundamental in shaping the learning process and developing an individual.

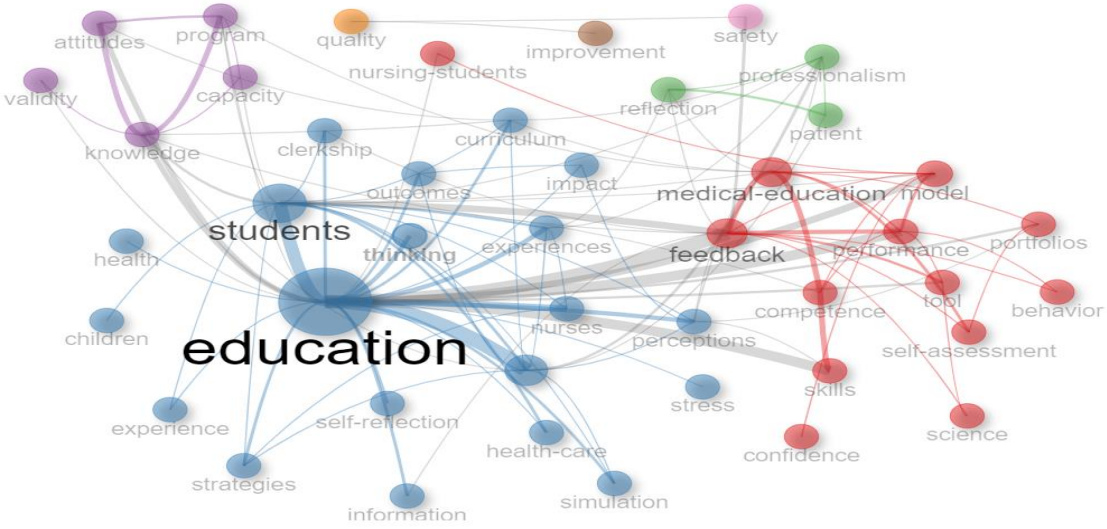

Figure 6: *Co-occurence Analysis Network Structure*

Orange Cluster 5: 'Quality Management': The key concept in this cluster is 'quality.' This concept implies that reflective learning processes can positively impact enhancing the quality of healthcare services. Quality management contributes to delivering healthcare services more effectively and efficiently, highlighting the significance of reflective learning processes. Brown Cluster 6: 'Continuous Improvement': Including 'improvement' as a key concept, this cluster emphasizes the critical importance of reflective learning in continuous improvement. Reflective learning enables an individual to continually develop and improve by leveraging their own experiences and knowledge. Pink Cluster 7: 'Patient Safety': The key concept in this cluster is 'safety,' indicating that reflective learning practices can positively affect patient safety. Reflective learning aids health professionals in evaluating their practices and enhancing patient safety. These clusters and evaluations reveal that reflective learning is a multifaceted and comprehensive subject in health sciences. The clusters highlight essential aspects of reflective learning, such as enhancing the quality of healthcare services, ensuring patient safety, and contributing to professionals' continuous development.

3.3.3 Co-Author Analysis

In scientific studies, co-authorship manifests intellectual collaboration [63]. Co-authorship reflects stronger social ties compared to other measures of relatedness. This makes co-authorship particularly suitable for examining social networks. Moreover, since it includes information about authors' institutional affiliations and geographical locations, co-author analysis allows for reading collaboration issues at the levels of institutions and countries [30]. In Co-Authorship analysis, the centrality degree of

an actor is taken as a basis, and the social network in the field is visualized [64]. While similar to co-citation analysis, co-authorship analysis differs in that co-citation analysis is conducted based on citations to authors' works. In contrast, co-authorship analysis is based on authors' joint works.

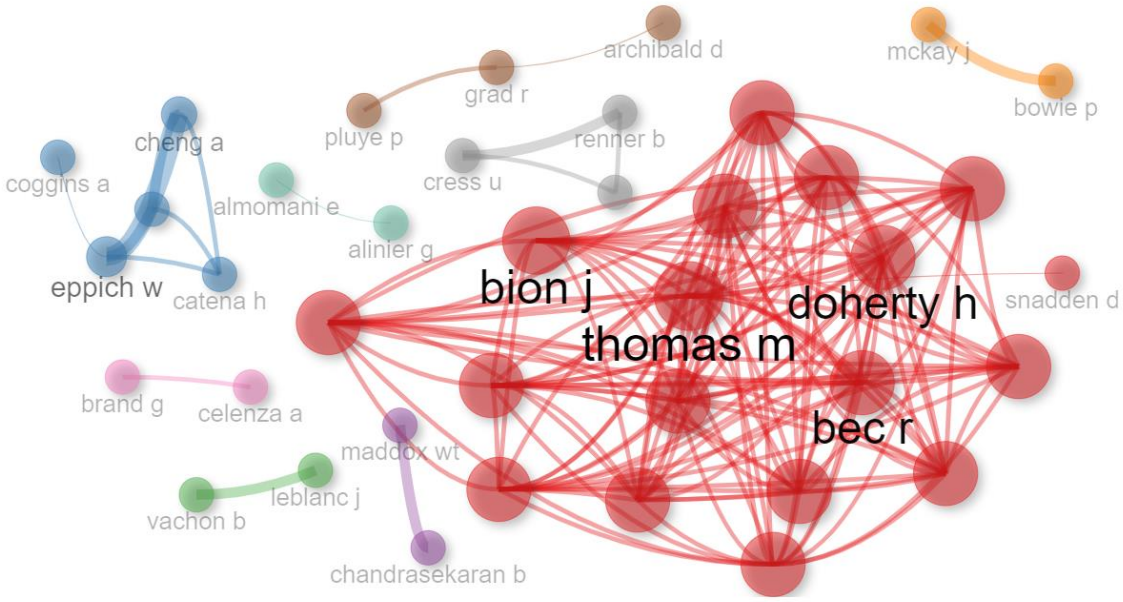

Figure 7: *Co-Author Analysis Network Structure*

Therefore, while co-citation analysis facilitates the identification of significant works, co-authorship analysis provides the opportunity to identify essential scientists [65]. On the other hand, a weakness of co-authorship analysis can stem from scientific fraud. Indeed, Katz and Martin (1997) have pointed out that not everyone named has contributed to the work, with some authors being added to studies for social reasons, and concepts such as honorary co-authorship exist [66]. The authors with the most co-authorship relationships are found in the red cluster, including Bion J., Thomas M., Doherty H., and Bec R. Subsequently, the authors addressing co-authorship cluster relationships are in the blue cluster, comprising Eppich W., Catena H., Coggins A., Cheng A.

4 Discussion

Reflective learning is an essential concept in education and teaching, and over time, it has manifested itself in various applications across different disciplines. Historically, our analysis suggests that reflective learning can be examined through three main periods representing themes from the earliest to the most recent studies. These periods demonstrate the evolution of reflective learning in education, its application in clinical and medical fields, and the integration of technology with reflective learning. The themes above highlight the historical changes and transformations in this area. In this discussion text, we will analyse the relationship of reflective learning with education, clinical and medical practices, and technology. We have named these three main period themes as the three main themes.

Reflective Learning in Education: Reflective learning is a strategy that enables students to learn from their experiences and develop their critical thinking skills. Studies titled 'Reflective Learning - The Key to Learning from Experience' and 'Reflective Learning as a Teaching Strategy for Critical Thinking' emphasize how this approach can transform students' thinking [9, 67]. Educators encourage students to process new information using their experiences and existing knowledge. This process allows students to learn more deeply and develop critical thinking skills.

Reflective Learning in Clinical and Medical Fields: In clinical and medical fields, reflective learning enables students and health professionals to draw lessons from their patient care experiences and transform these experiences into better practices [9]. Studies such as 'My Most Meaningful Patient' and 'Reflective Learning in a Patient Safety Course for Final-Year Medical Students' demonstrate how reflective learning is utilized in medical education [68, 69]. This approach allows medical students and healthcare workers to analyse their challenges and successes, integrating the knowledge and skills gained in the process into their clinical practices.

Technology and Reflective Learning: The role of technology in education is increasingly significant, and reflective learning occupies an essential place in this process. Studies like 'The Impact of Technology on Reflective Learning in Dental Hygiene Education' and 'Computer-assisted Reflective Learning: How Applications Can Promote Reflection in the Workplace' examine how technology supports reflective learning [70, 71]. Technology enables students and professionals to record, analyze, and more effectively share their experiences. Mainly, mobile applications and online platforms facilitate the reflective learning process and extend its reach to a broader audience.

Reflective learning is an approach that can be applied across a broad spectrum, from education to healthcare services and technology. Implementing this approach enables students and professionals to learn more deeply from their experiences and enhances their critical thinking skills [16]. Reflective learning is vital in supporting individuals' continual development and adaptation abilities, especially in the rapidly changing and evolving modern world [1].

Evaluation from the perspective of co-occurrence analyses: Based on the results of co-occurrence analysis in health sciences and reflective learning, the seven emerged clusters cover a wide range from education to patient safety. The first cluster focuses on the importance of feedback and self-assessment in medical education, while the second cluster addresses the impact of healthcare services education on student experiences [22]. The third cluster emphasizes professionalism and patient interaction, and the fourth cluster highlights the roles of knowledge and attitudes in the learning process. The fifth cluster discusses the contribution of quality management to reflective learning processes, while the sixth cluster points to the importance of continuous improvement processes. The seventh and final cluster foregrounds the role of patient safety in reflective learning processes.

The topics within each cluster offer significant insights into the future of health education and services. The evolution of educational processes from traditional methods to interactive and student-centered approaches, the adaptation of students and educators to these new methods, and efforts to maintain objectivity are becoming prominent. Additionally, health professionals' experiences in reflective learning processes influence their perception of patient care and professionalism, enhancing the human-centered aspect of healthcare services. Quality management and continuous improvement processes contribute to the efficiency and effectiveness of healthcare services. Each cluster plays a critical role in enhancing the quality of healthcare services and education, with a central focus on patient safety. The evaluation of these clusters demonstrates that reflective learning plays a versatile and comprehensive role in health sciences. Reflective learning is an indispensable tool in health sciences with its various aspects, such as improving the quality of healthcare services and patient safety, ensuring the continuous development of professionals, and enriching educational processes.

Evaluation in terms of co-citation analyses: The similarities and differences between the themes in the 'Three Main Periods' and 'Co-Citation Clusters' files can be summarized as emphasizing the importance of reflective learning and its various application areas:

Similarities: Focus on Reflective Learning Approaches: Reflective learning is emphasized in both files. The 'Three Main Periods' file focuses on the relationship of reflective learning with education, clinical

and medical practices, and technology, while the 'Co-Citation Clusters' file deals with themes such as reflective learning processes and practices, reflective learning with debriefing in health simulations, and reflective learning in general. These themes concentrate on integrating reflective learning in health education, student development, and enhancing professional competencies. Professional Development and Educational Practices: In both files, there is a focus on how professionals and students can learn from their experiences and how they can apply this learning in practice.

Differences: Specific Emphases and Methods: The 'Three Main Periods' file addresses specific themes, such as the integration of technology with reflective learning, while the 'Co-Citation Clusters' file includes a broader and more diverse range of sub-themes, such as the dynamics of reflective practice in professional development, the critical incident technique in the reflective learning process, and transformation in adult education. Relationship Between Practice and Theory: In the 'Co-Citation Clusters' file, the impact of reflective learning on health education is examined from a more theoretical and methodological perspective, whereas the 'Three Main Periods' file focuses on the practical integration of reflective learning with education, clinical and medical practices, and technology.

5 Conclusion

These comparisons show that both files have unique emphases and application areas regarding reflective learning. While the 'Co-Citation Clusters' file offers a broad theoretical framework, the 'Three Main Periods' file presents content more directed towards specific and practical application areas.

6 Research Limitations and Future Research

In bibliometric studies, co-citation, co-occurrence, and co-authorship analyses are commonly used methods, yet they also have certain limitations [24, 30, 72]. Firstly, these analyses often rely on publications from limited databases, which can affect the scope and reliability of the results. Therefore, future research could deepen analyses by integrating databases such as WoS and Scopus. Secondly, the diversity of research terms and concepts, language differences, and interdisciplinary terminological differences can limit the accuracy of the analysis [27, 28]. Thus, future research could replicate studies using different search strategies. Thirdly, analyses conducted within a specific timeframe may not reflect the latest developments in rapidly evolving fields. Therefore, it is crucial for future research to identify new development patterns in these areas through bibliographic coupling analysis.

Fourthly, focusing on highly cited works may lead to the oversight of lesser-known studies. The methodological limitations of co-citation, co-occurrence, and co-authorship analyses are confined to the quantitative assessment of relationships among publications, which may not fully represent the nature and context of these relationships. While these analyses reflect the current state of a research field, they do not consider the dynamics and changes over time, leading to limitations, especially in analysing new and rapidly evolving topics. Therefore, future research could focus on systematic literature reviews and qualitative analyses to perform in-depth analyses.

Fifthly, the contributions of reflective learning to various health science disciplines, such as nursing, medicine, and public health, can be systematically explored. In these studies, employing a mixed-methods approach to investigate how reflective practices affect clinical decision-making, interdisciplinary teamwork, patient outcomes, and the overall resilience and adaptability of healthcare professionals would be valuable. Finally, research could be designed to examine the integration of reflective learning into curricula and its impact on the preparedness of students transitioning to clinical settings. Additionally, these studies could investigate potential barriers to and facilitators of effective reflective learning in educational settings and professional practice.

7 Declarations

7.1 Study Limitations

The research utilized a limited database. The diversity of research terms and concepts, language differences and terminological differences across disciplines may limit the accuracy of the analysis. Articles from a specific time period were analyzed in the study. The most cited studies were included in the article.

7.2 Ackowledgements

There are no individuals or organizations other than the authors who contributed to this research.

7.3 Funding Source

No financial support was received for this research.

7.4 Competing Interests

This study has no conflict of interest.

7.5 Authırs Contributions

Buket ÖGET: All authors contributed equally.

Mehmet Nurullah KURUTKAN: All authors contributed equally.

Mehmet BAĞIŞ: All authors contributed equally.

8 Human and Animal Related Study

8.1 Ethical Approval

Since the article was written as a bibliometric analysis, no ethical approval is required in our study within the framework of ethical rules and policies.

8.2 Informed Consent

Since this study was a bibliometric analysis, informed consent was not required.

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