

A Bibliometric Analysis of Thinking Skills Research: Trends and Patterns from 1980 to 2025
1980–2025 Dönemi Düşünme Becerileri Araştırmalarının Bibliyometrik Analizi: Eğilimler ve Desenler

Ayşe Ahsen Talu¹ 

¹Dr. Öğr. Üyesi, Balıkesir Üniversitesi, Necatibey Eğitim Fakültesi, Balıkesir, Türkiye

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Ayşe Ahsen Talu

Balıkesir Üniversitesi,
Necatibey Eğitim Fakültesi,
Eğitim Bilimleri Bölümü,
Balıkesir

ahsentalu@gmail.com

Abstract: When defined as a skill, the acquisition and assessment of thinking abilities have been the subject of various studies. This study conducts a bibliometric analysis of the growing literature on thinking skills using data from the Web of Science (WoS) Core Collection. A total of 967 publications from 1980 to 2025 were analyzed with R Studio-Biblioshiny, following Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines. Results show a publication peak in 2024 and a citation peak in 2003. Thinking Skills and Creativity emerged as the most influential journal, and Universitas Negeri Malang was among the most productive institutions. The United States, Indonesia, and Turkey were identified as leading contributors. Collaboration networks were observed among country clusters, with “artificial intelligence” highlighted as the top trending topic in 2025. Despite the growing interest in thinking skills, international collaboration remains limited, and research is increasingly shifting toward AI-based educational applications. Thus, future studies should investigate the role of artificial intelligence in fostering thinking skills.

Keywords: Thinking skills, higher order thinking skills, PRISMA, Bibliyometrik analysis, Biblioshiny

Öz: Düşünme bir beceri olarak tanımlandığında, bu becerinin edinimi ve ölçülmesine dair çeşitli araştırmalar yürütüldüğü bilinmektedir. Bu çalışma, düşünme becerileri üzerine genişleyen literatürü Web of Science (WoS) Core Collection verileri kullanarak bibliyometrik açıdan analiz etmektedir. 1980–2025 yılları arasında yayımlanmış toplam 967 yayın, Sistematik Derleme ve Meta-Analiz için Tercih Edilen Raporlama Öğeleri (PRISMA) yönergeleri doğrultusunda R Studio-Biblioshiny aracılığıyla analiz edilmiştir. Sonuçlar, yayın sayısında 2024 yılında bir zirveye, atıf sayısında ise 2003 yılında bir tepe noktasına ulaşıldığını göstermektedir. Thinking Skills and Creativity en etkili dergi olarak öne çıkarken, Universitas Negeri Malang en üretken kurumlar arasında yer almıştır. Amerika Birleşik Devletleri, Endonezya ve Türkiye en fazla katkı sağlayan ülkeler olarak belirlenmiştir. Ülkeler arası iş birliği ağlarının kümeler şeklinde oluştuğu gözlemlenmiştir; 2025 yılı itibarıyla “yapay zekâ” en çok öne çıkan konu olmuştur. Düşünme becerilerine yönelik ilgi artmasına rağmen uluslararası iş birliği sınırlı kalmakta, araştırmalar giderek yapay zekâ temelli eğitim uygulamalarına yönelmektedir; bu nedenle gelecekteki çalışmaların yapay zekânın düşünme becerilerinin gelişimine etkisini incelemesi önerilmektedir.

Anahtar Kelimeler: Düşünme becerileri, üst düzey düşünme becerileri, PRISMA, bibliyometrik analiz, Biblioshiny

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Introduction

Thinking is a natural process of the human mind (French & Rhoder, 1992). It is known that the roots of thinking go back to the beginning of humanity. When thinking is not valued or seen as a pointless act, this can affect quality of life. For a successful and productive life, individuals are expected to have the ability to think effectively. Good thinking can help people become more successful and efficient. Mental development and quality thinking can be achieved through systematic thinking (Güneş, 2012). In the face of rapid changes in the world and society, the ability to adapt to these changes is a crucial factor for achieving success. Therefore, individuals who possess creative thinking skills across various contexts tend to stand out through their accomplishments (Gafour & Gafour, 2020).

The growing emphasis on thinking abilities inevitably invites a more rigorous examination of how these skills function within the complex and rapidly shifting conditions of the contemporary world. With the growth of technology, the rapid increase in information, and globalization, simply having knowledge is no longer as important as it used to be. In the 21st-century, what matters more is how people use knowledge effectively and how it helps them solve problems. For example, children face problems at school, at home, and in their social lives. They try to solve these problems in their own ways. Whether their solutions come from personal traits

(like self-confidence or determination) or from thinking skills depends on how much they have developed abilities like analytical thinking and problem-solving. These skills are important throughout life (Newman, 1977). According to the World Economic Forum [WEF], traditional teaching methods do not help students gain the skills they really need. This creates a gap between what students learn in school and what they need in real life (WEF, 2016). Because of this, education systems and programs should focus more on improving thinking skills.

Theoretical Perspectives and Classifications of Thinking Skills

The English National Curriculum (ENC) lists thinking skills as processing information, reasoning, asking questions, creative thinking, and evaluating. These skills are similar to those identified by many researchers (Wegerif et al., 2002). Additionally, Presseisen (1984) classified thinking skills into four main categories: creative thinking, critical thinking, problem solving, and decision making. In Bloom’s original taxonomy (1956), higher-order thinking skills were identified as analysis, synthesis, and evaluation. Later, in the revised version of Bloom’s taxonomy by Anderson and Krathwohl (2001), these were updated and redefined as analyzing, evaluating, and creating. For example, critical thinking helps people not only find correct information but also organize it, understand it, and make smart decisions (Sönmez & Sağlam,

2025). Creativity is known to develop through a mix of personal traits and thinking abilities. So, it is important to identify and support people's creative potential (Dilekçi & Karatay, 2023). Developing creativity and critical thinking is important for preparing people for work and a good life. However, teachers often do not have enough knowledge about how to teach these skills. Also, it is not clear how well these skills are present in learners (OECD, n.d.).

Developing Thinking Skills in Education

The focus on thinking in education is because it is a skill that can be improved through teaching. When schools and classrooms are set up to help develop thinking skills, academic success is expected. School education is part of a "culture of thinking," which includes thinking language, attitudes, mental control, strategies, advanced knowledge, and teaching how to apply learning (Noor, 2008). A culture of thinking creates a good environment for thinking skills to grow. This culture can be built in classrooms where teachers understand the importance of thinking skills and guide students. The way thinking skills are defined plays a critical role in shaping their instruction; vague or imprecise definitions can lead to ineffective teaching and learning, whereas clear and detailed conceptualizations promote more effective instruction and skill acquisition (Beyer, 1984).

In this context, the integration of modern educational technologies can further enhance the development of thinking skills by providing supportive learning environments. Educational technologies are essential for delivering efficient and high-quality education. When combined with methods like project-based and adaptive learning, they play a crucial role in developing key 21st-century skills such as communication, creativity, and collaboration (WEF, 2015). These technologies enable the education system to better support 21st-century competencies. Among these, critical thinking, creative thinking, decision-making, problem-solving, learning how to learn, and cognitive awareness are particularly important and closely linked to thinking skills (Berkant & Varki, 2022). Using 21st-century skills means students need to have a good understanding of basic school subjects. People who can think carefully and communicate well should build these skills on strong knowledge. While learning basic subjects, students also need to practice important skills like critical thinking, problem-solving, communication, and working with others to do well in today's world (Partnership for 21st Century Learning [P21], 2007).

Given the central role of these skills in education, it is crucial to understand how they are supported and developed within classroom practices. Teachers use different ways to help students develop thinking skills. Some give students many chances to practice on their own. Others guide and support students' thinking. Sometimes, teachers need to encourage students to think more deeply and critically (Beyer, 2008). Dilekli and Tezci (2020) found that teachers' confidence in teaching thinking skills changes based on factors like country, gender, subject, and experience. In another study, they showed that teachers' confidence and teaching styles affect how they teach these skills (Dilekli & Tezci, 2016). These results show that students can develop thinking skills when teachers have the skills and confidence to teach them well.

Trends in Thinking Skills Research

Creativity and critical thinking are important skills for young adults to succeed personally, professionally, and socially in the

21st-century. Studies and policies show that these skills matter for economic growth, innovation, and social inclusion. Universities have a key role in helping students develop these skills through courses, programs, and assessments (OECD, 2023). Therefore, having good thinking skills is very important for overall development. Fostering students as competent thinkers has long been regarded as a fundamental objective of education. However, this goal has remained largely unfulfilled in many schools. Recent research offers new insights into the nature of human thinking, suggesting that emerging educational approaches informed by these findings hold significant potential to enhance students' thinking competencies (Resnick & Klopfer, 1989).

Previous studies explore thinking skills from different angles. In teacher training, researchers have studied various parts and types of thinking skills (Hursen, 2021; van den Berg & du Plessis, 2023; Lorencová et al., 2019). There are also studies on thinking skills in higher education (Behar-Horenstein & Niu, 2011; Karunaratne & Calma, 2024; Lonka & Ahola, 1995; Van Damme et al., 2023) and early childhood education (Karadağ & Demirtaş, 2018; Yaşar & Aral, 2012). Kania et al., (2025) reviewed how higher-order thinking skills are measured, and Huber and Kuncel (2016) analyzed studies about critical thinking skills.

Some studies also use bibliometric methods to give an overview of research on thinking skills. These include work on critical thinking (Arthi et al., 2025; Lestari, 2024; Nuryana et al., 2024; Purnama, 2024; Valderrama et al., 2025), reflective thinking (Korkmaz & Toraman, 2024), higher-order thinking (Lismaya et al., 2025; Mulyani et al., 2024), creative thinking (Andriyono et al., 2024), and problem solving (Cheruiyot & Molnár, 2025; Yuniasih et al., 2025). While the reviewed studies indicate that bibliometric analyses have been conducted on specific types of thinking skills, no study has been identified that comprehensively addresses thinking skills in a broader sense.

The Present Study

This present study analyzes trends in research on thinking skills using quantitative and bibliometric evidence from publications indexed in the Web of Science (WoS) Core Collection over a 50-year period (1980–July 2025). The findings are expected to provide valuable insights for guiding the future directions of research on thinking skills.

The study aims to address the following research questions (RQs);

RQ1

How has the annual scientific production on thinking skills and the corresponding yearly citation counts evolved over time?

RQ2

Which sources are the most relevant in the field, and how has their local impact (h-index) changed over time?

RQ3

How has the scientific production of institutions and countries developed over time, and from which countries do the corresponding authors originate?

RQ4

Based on bibliometric analysis, what are the trending topics and the main research clusters in thinking skills research?

Method

A bibliometric analysis based solely on the WoS was preferred because WoS offers a rigorously curated collection of journals, consistent and high-quality bibliographic data, and a structure well suited for conducting citation-based evaluations and mapping scholarly collaboration patterns. Using a single, standardized database also minimizes potential problems such as duplicated records, discrepancies in indexing practices, or format inconsistencies that often occur when datasets from multiple sources are merged. Accordingly, WoS was selected as the exclusive data source to preserve the coherence and reliability of the study's methodology. To ensure methodological transparency and reproducibility, the study was reported in accordance with the PRISMA guidelines and the PRISMA checklist (Appendix 1) (Page et al., 2021). The overall research process was structured in seven steps, as illustrated in Figure 1.

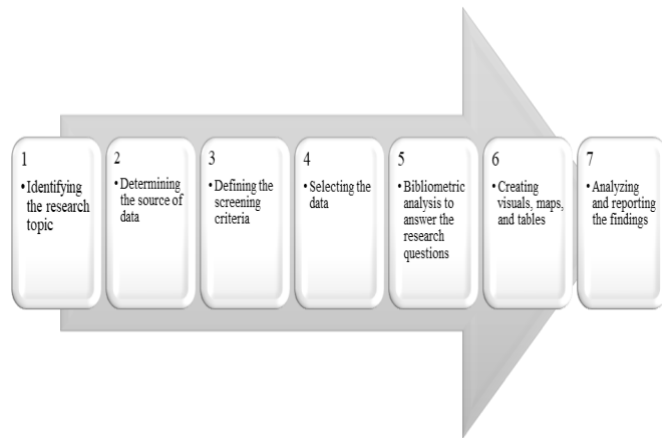


Figure 1. Bibliometric research process

The research was conducted in seven sequential stages: first, thinking skills were selected as the research topic; second, the data source was determined (see Methods section); third, screening criteria were defined (Table 1); fourth, data were collected through a WoS search; and finally, the fifth to seventh stages involved bibliometric analyses carried out using the Biblioshiny application.

Procedure

Table 1. Inclusion and exclusion criteria

Category	Criteria
Inclusion	Title field contains: "thinking skills*" OR "higher-order thinking skills*" OR "higher order thinking skills*"
	Only articles
	"Education Educational Research" or "Education Scientific Disciplines"
	Turkish and English
Exclusion	All years (no restriction)
	Retracted publications
	Proceedings papers
	Book chapters

The PRISMA flow diagram illustrating the literature screening process is presented in Figure 2.

Findings

In this section of the study, the findings obtained from the bibliometric analysis are presented in order. General information about the studies is provided in Table 2.

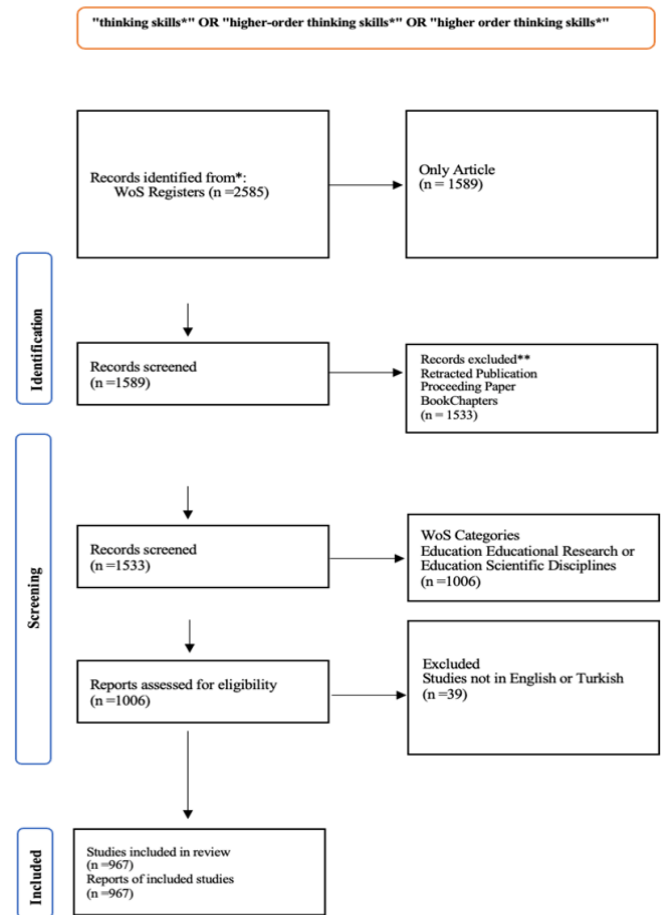


Figure 2. PRISMA flow diagram

Table 2. Main information about data

Timespan	1980:2025
Sources (Journals, Books, etc)	288
Documents	967
Annual Growth Rate %	8.66
Average citations per doc	14.62
Authors	
Authors	2599
Authors of single-authored docs	172
Authors Collaboration	
Single-authored docs	184
Co-Authors per Doc	3.02
International co-authorships %	12.2

Table 2 provides an overview of the studies included in the bibliometric analysis. Between 1980 and 2025, 967 documents were published across 288 different sources. The annual growth rate of scientific output is 8.66%, and the average number of citations per document per year is 14.62. A total of 2,599 authors contributed to these publications. Of these, 172 documents were authored by a single researcher, and there are 184 single-authored documents in total. The average number of co-authors per document is 3.02. The rate of international collaboration among the analyzed documents is 12.2%. Annual scientific production is shown in Figure 3.

Figure 1 presents the annual scientific production between 1980 and 2025. While only two studies on thinking skills were conducted in 1980, this number increased to 84 in 2025. Considering that additional studies may be published after the search date, it is likely that the total for 2025 will increase further. Although the number of publications followed a relatively stable trend from 1980 to 2004, an overall upward trend is observed after 2004, despite some fluctuations. The

number of studies (n=123) peaked in 2024. However, a decline in publication volume is noticeable after 2024. The decline observed in 2025 should be interpreted with caution, as 2025 represents a partial year based on data collected up to July 8, 2025. Figure 4 shows the annual citations per year.

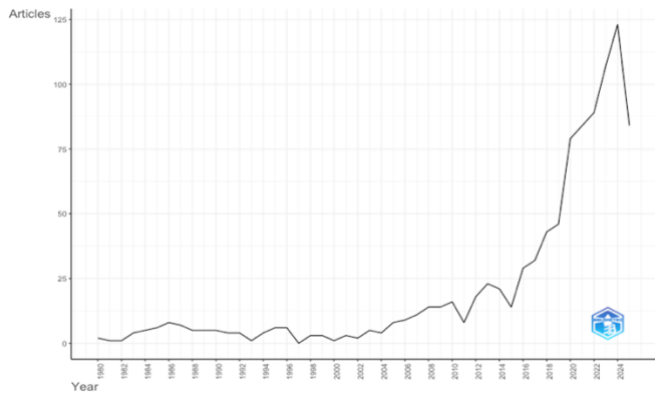


Figure 3. Annual scientific production

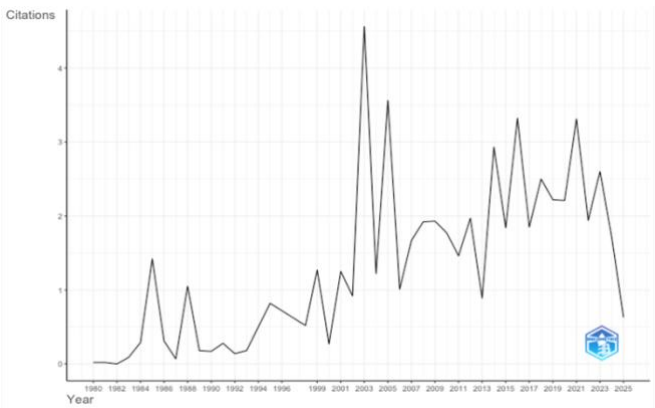


Figure 4. Annual citations per year

Figure 4 presents the annual citation counts, which show a fluctuating trend rather than a consistent increase or decrease. This indicates that academic interest in the topic has changed over time. Periods of higher or lower citation activity may reflect shifts in the relevance or visibility of the subject in different years. The highest average citations per year were recorded in 2003, with a value of 4.6. This indicates that, on average, each article published in 2003 has received 4.6 citations per year since its publication. Figure 5 displays the most relevant sources that have contributed significantly to the literature.

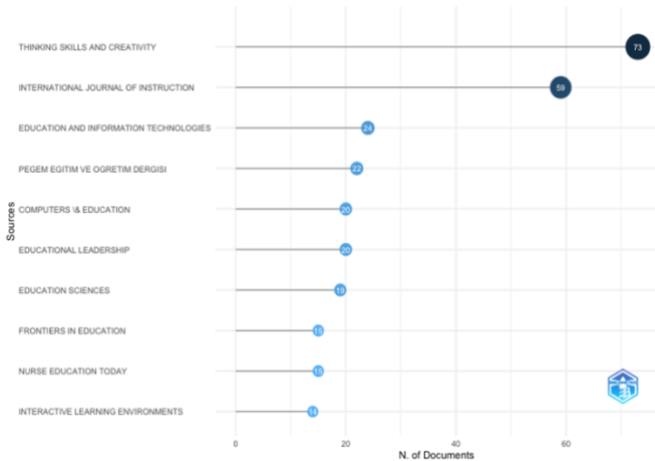


Figure 5. Most relevant sources

The ten most relevant sources on thinking skills are listed in Figure 5. The leading source is Thinking Skills and Creativity (n=73). Other prominent journals include the

International Journal of Instruction (n=59), Education and Information Technologies (n=24), PEGEM Journal of Education and Instruction (n=22), Computers & Education (n=20), and Educational Leadership (n=20). Ranked first, Thinking Skills and Creativity is an international journal launched in 2006, known for addressing innovative and significant topics related to the teaching of creativity and thinking skills. Table 3 presents the local impact of the sources based on their h-index.

Table 2 lists the local impact of sources based on their h-index. While Thinking Skills and Creativity appears as one of the most relevant journals on thinking skills, Computers & Education ranks equally in terms of local impact. Although most of the listed journals are prominent in the field of education, the h-index of the International Journal of Instruction is 12. Nurse Education Today stands out as a journal focused on nursing education. The presence of this journal may be explained by the considerable number of studies addressing critical thinking in nursing education (e.g., Chan, 2013; Kanbay & Okanlı, 2017; RN & RN, 2002; Zygmunt & Schaefer, 2006). As Brunt (2005) also emphasized, the development of critical thinking skills is of great importance for healthcare professionals to solve complex problems.

Table 3. Sources' Local Impact by h-index

Source	h_index
Computers & Education	18
Thinking Skills and Creativity	18
International Journal of Instruction	16
Nurse Education Today	12
Interactive Learning Environments	8
International Journal of Emerging Technologies in Learning	8
Education and Information Technologies	7
Education Sciences	7
Educational Leadership	7
Etr&D-Educational Technology Research and Development	7

Leading journals with high h-index values, such as Interactive Learning Environments, International Journal of Emerging Technologies in Learning, Education and Information Technologies, and ETR&D-Educational Technology Research and Development, primarily focus on technology. In contrast, Educational Leadership is recognized as a key journal featuring studies that examine thinking skills within the context of educational leadership. The publication trend over time of the most locally cited sources is presented in Figure 6.

The publication trends of the six most locally cited sources are shown below. In 2008, Computers & Education and Thinking Skills and Creativity also began publishing related work. Compared to Computers & Education, Thinking Skills and Creativity shows a sharper increase in output. Educational Leadership had an increase in publications between 1980 and 1990, then remained stable, with 18 to 20 publications per year after 1990. PEGEM Journal of Education and Instruction had no publications on the topic until 2021, but has shown a clear increase since then, with similar numbers in 2024 and 2025. Education and Information Technologies began publishing on the topic in 2018, with a gradual, though not consistent, increase until 2025. Publications in the International Journal of Instruction began to rise in 2016 and have continued to grow. By 2025, the two journals with the highest number of

publications are Thinking Skills and Creativity (n=73) and International Journal of Instruction (n=59). Figure 7 shows the publication trends by institution over time.

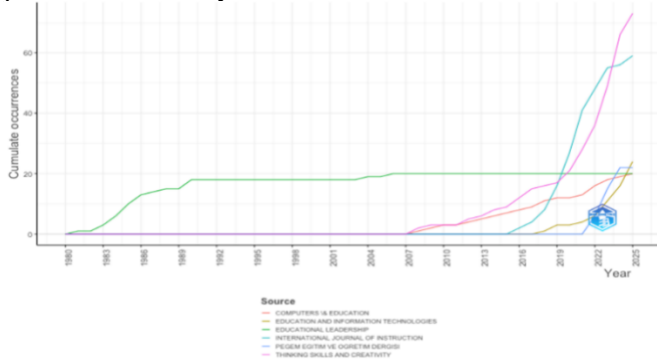


Figure 6. Most local cited sources' production over time

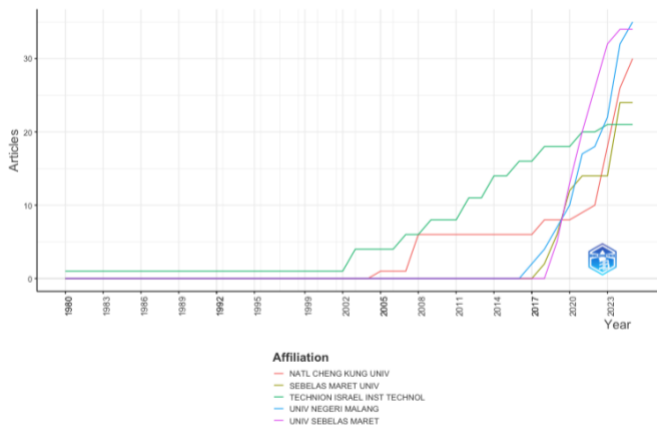


Figure 7. Affiliations' production over time

Figure 7 presents the publication output over time of the top five most productive institutions in the field. The data show that the Technion – Israel Institute of Technology did not produce research on thinking skills until 2002. Since then, its publication trend has fluctuated, showing periods of growth and stability. Universitas Sebelas Maret has shown a notable increase in publications since 2018, while Universitas Negeri Malang has consistently been among the top contributors and reached the highest output level in 2024. Similarly, Universitas Sebelas Maret began publishing on the topic in 2017 and has maintained steady output since then. National Cheng Kung University has been among the leading institutions in terms of publication volume since 2004. In summary, one institution each from Taiwan, Malaysia, and Israel, along with two institutions from Indonesia, have emerged as key contributors to research on thinking skills. Figure 8 shows the countries of the corresponding authors.

Figure 8 illustrates the distribution of Single Country Publications (SCP) and Multiple Country Publications (MCP), representing collaborations among authors from the same country and from different countries, respectively. Based on the analysis of corresponding authors, the United States (U.S.) ranks first among the top 20 countries, followed by Indonesia and Turkey. Although the U.S. leads in the number of publications, it shows a relatively low level of international collaboration. Similarly, other leading countries also demonstrate limited engagement in cross-country research partnerships. In contrast, countries such as Greece, India, and the Netherlands exhibit research activity primarily through domestic collaborations, indicating a lack of international engagement. Notably, Mexico stands out as the only country

among the top 20 where a majority of studies (5 out of 8) were conducted through international collaboration, accounting for 62.5% of its total output. This suggests that researchers in Mexico are relatively more proactive in establishing cross-border academic partnerships. Country production over time is shown in Figure 9.

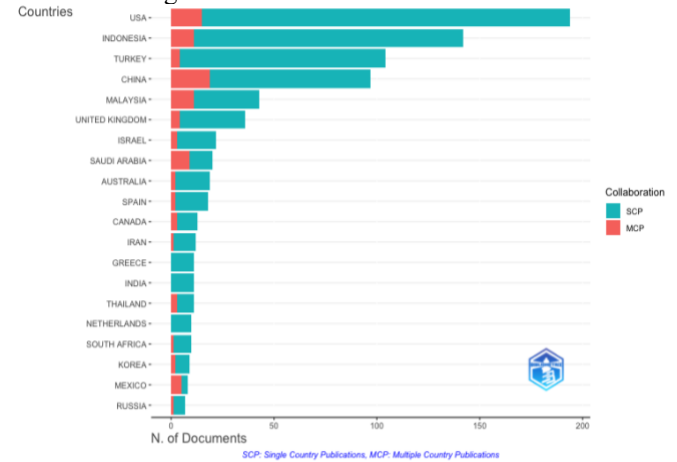


Figure 8. Corresponding authors' countries

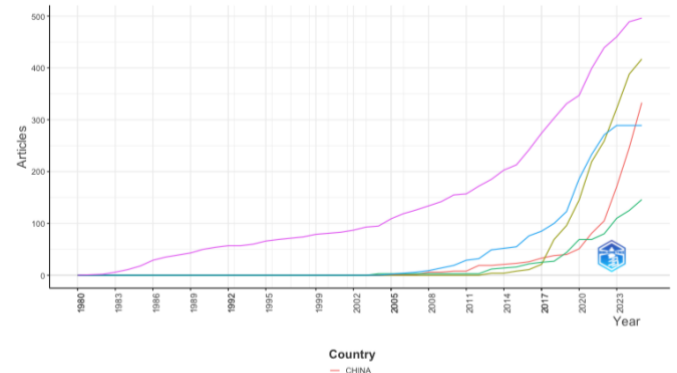


Figure 9. Country production overtime

Figure 9 presents the scientific production trends of countries over time. The U.S. has demonstrated a consistently increasing publication output in the field of thinking skills. In recent years, countries in the Asia-Pacific region particularly Indonesia, Malaysia, and China have shown a significant rise in research activity. Turkey also stands out with a notable upward trend until 2021, its publication rate has remained stable since then. As of 2025, the countries with the highest number of publications are the U.S. ($f = 496$), Indonesia ($f = 417$), China ($f = 333$), Turkey ($f = 289$), and Malaysia ($f = 146$). These figures indicate a growing academic interest in thinking skills, especially in these countries. Figure 10 displays the Collaboration Network Among Countries, highlighting patterns of international research cooperation.

Figure 12 presents clusters based on bibliographic coupling, illustrating the connections among the texts analyzed in this study. Two distinct clusters emerged based on shared references, reflecting thematic or conceptual proximity. The first cluster is labeled (education-dispositions-students), while the second is (validity-robotics-education). The first cluster groups studies related to thinking skills from the perspective of student attitudes within the educational process. In contrast, the second cluster comprises research focusing on the validity of robotics education. The first cluster emphasizes human-centered applications and student

disposition, whereas the second cluster highlights a technology-driven approach, concentrating on the validation of robotic applications. Moreover, the larger size of the first cluster indicates a greater number of studies within this group. The terms “dispositions” (100%), “robotics” (100%), and “validity” (96%) exhibit strong internal coherence within their respective clusters. Although “education” appears in both clusters (61.4% and 38.6%), it does not hold the same central role across them. The three-field plot illustrating the relationships among key concepts, authors, and sources is presented in Figure 13.

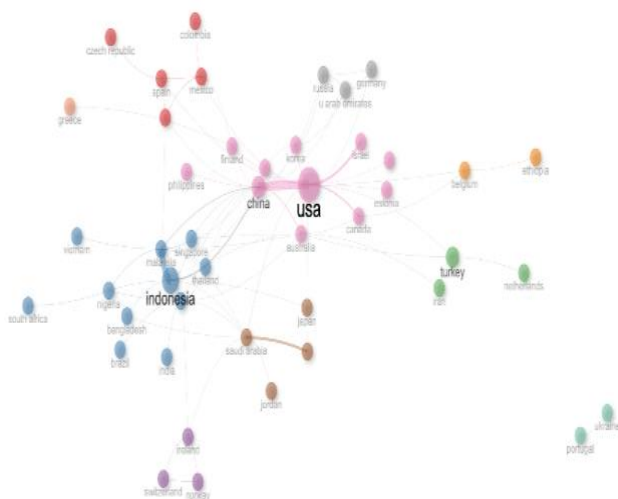


Figure 10. Collaboration network among countries

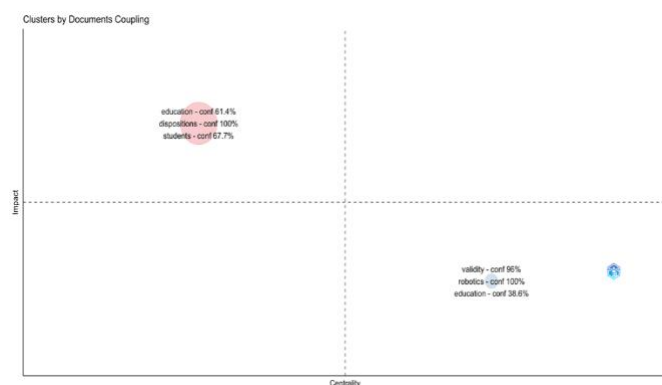


Figure 11. Trend topic

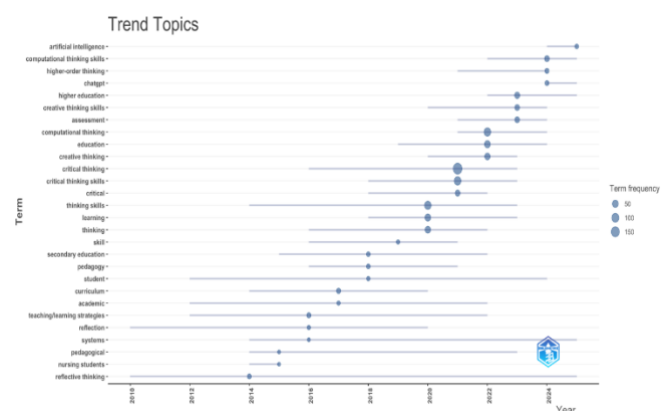


Figure 12. Clusters by documents coupling

Discussion and Conclusion

Globally, there is significant interest in research on thinking skills. The increasing presence of thinking skills focused questions in international assessments has driven a growing body of work on how these skills can be developed through education. Moreover, cultivating individuals with advanced

thinking skills is crucial for the workforce. For instance, the Programme for International Student Assessment (PISA) 2022 emphasized the evaluation of creative thinking (OECD, 2022b). Additionally, in fields heavily reliant on mathematics, the development of critical thinking, problem-solving, and cognitive skills is actively encouraged, with the PISA 2021 framework specifically targeting the assessment of these competencies. Higher education institutions play a fundamental role in fostering thinking skills through curriculum design, instruction, and assessment (Bouckaert, 2023). This study is based on a bibliometric analysis of 967 studies on thinking skills conducted between 1980- July 2025 in the WoS Core Collection. It has been observed that studies on thinking skills peaked in 2024. In the study conducted by Yücel (2025), it was determined that research on critical thinking skills has increased in recent years, with a notable rise observed particularly in 2023. Studies on higher-order thinking skills in Turkey also increased between 1992 and 2023 (Öz, 2023).



Figure 13. Three-field plot

The number of citations to the studies varied by year, with the highest number of annual citations recorded in 2003. PISA 2003 marked a significant advancement by introducing the assessment of problem-solving skills, distinct from other competencies (OECD, 2004). This initiative provided a comprehensive evaluation of students' abilities to address real-life challenges, encompassing tasks such as identifying problems, selecting relevant information, and developing solution strategies. Consequently, it can be suggested that this development has led to a shift in researchers' focus, and based on the changes observed in both annual publication counts and citation rates, the interest in thinking skills research appears to have evolved over time. The increase in citation counts observed in 2003 and the fact that, despite occasional fluctuations, citation and publication rates have maintained a certain momentum since then may indicate that the field has gained stable and enduring scholarly visibility from that point onward. Moreover, including publications up to July 2025 and the increased number of articles on the topic may have diluted citations per article, leading to a decrease in average citation rates (Sjögårde & Didegah, 2022).

The most relevant source regarding thinking skills is the journal *Thinking Skills and Creativity*. When evaluated by the local impact of sources according to their h-indices, it can be stated that *Computers & Education* and *Thinking Skills and Creativity* are two journals with noteworthy publications in the field, each having an h-index of 18. According to Hirsch (2005), the h-index provides significant information in terms of both quality and quantity. At the same time, the h-index offers insights into a journal's academic impact and sustainability. In the study conducted by Şahin et al. (2023), it

was demonstrated that the journal *Thinking Skills and Creativity* is an influential journal in the field. Citation analysis related to higher-order thinking skills revealed that the authors with the highest number of citations published in journals with high impact values (Öz, 2023).

When evaluating the production of the most cited local sources over time, it is observed that the journals *Educational Leadership* and *Thinking Skills and Creativity* stand out. It can be stated that these journals occupy a central position both in terms of academic productivity and impact level. When the publication output of institutions over time is assessed, it is understood that Universitas Negeri Malang in Malaysia leads in the number of publications. Additionally, Universitas Sebelas Maret in Indonesia also demonstrates a noteworthy publication potential. It is understood that Malaysia, Indonesia, and Taiwan focus on thinking skills. The Ministry of Education in Taiwan requires high school teachers to design activities aimed at improving students' critical thinking skills (Tseng, 2020). This demand may be related to the high numbers in publication output.

When the analyzed studies are examined according to the countries of the corresponding authors, although the U.S., Indonesia, and Turkey rank in the top three, they appear to be insufficient in establishing international collaborations. Turkey's recent successes in exams such as PISA and the Trends in International Mathematics and Science Study (TIMSS) (OECD, 2022a) can be explained by the focus on higher-order thinking skills in its education programs (Ministry of National Education [MoNE], 2025). Asia-Pacific countries such as Indonesia, Malaysia, and China also attract attention with their studies on the relevant topic. In the bibliometric analysis conducted by Dong and Chang (2023), it was noted that Asia ranks first, especially in studies on critical thinking skills over the past 20 years, followed by the U.S. and Europe. When evaluated in terms of scientific production, it has been understood that the U.S. ranks among the top in this field, while Indonesia and China are also among the top three in academic productivity regarding thinking skills. The U.S. National Science Foundation [NSF] demonstrates the importance it places on this field through various projects it supports and funds related to different areas of thinking skills (National Science Foundation [NSF], 2024).

The standards related to the curriculum revised by China in 2022 focus on developing students' analysis, problem-solving, and higher-order thinking skills (Chaojing, 2023). The assessment and evaluation in Indonesia emphasize the evaluation of higher-order thinking skills (Nizam, 2016, as cited in Widana, 2017). Furthermore, in alignment with Malaysia's 2013–2025 education plan, teachers are aware of the importance of higher-order thinking skills and recognize that these skills need to be integrated into lessons for student success (Sulaiman et al., 2017).

When international collaborations are evaluated, global inter-country collaborations have formed seven clusters. It can be said that there are different reasons behind the formation of these international collaboration clusters. National research networks may vary in terms of geographic regions and thematic connections. Some networks may originate from linguistic commonalities, others from geographic proximities, and still others from certain historical relationships extending from the past to the present. Despite advancements in information and communication technologies, Pan et al. (2012) revealed that geographical proximities continue to influence citation and collaboration networks. The

establishment of international collaborations is thought to be related to some historical ties and linguistic commonalities.

For example, the first cluster represents an academic collaboration network predominantly comprising Spanish-speaking countries. The second cluster consists of English-speaking countries with historical ties to British governance. The third cluster includes states located in close geographic proximity, such as Turkey and Iran, while also recalling student mobility programs like the Erasmus+ within European countries, such as the Netherlands. The fourth cluster points to countries in Western Europe that have small populations but strong research potential. It can be inferred that the relationships in the other clusters stem from projects carried out by universities, inter-country agreements, and academic partnerships among researchers. It is stated that geographical proximity has a significant impact on collaborations, with cognitive and relational proximities and author collaborations being limited (Tuncer & Gezici, 2024).

According to the Three-Field Plot analysis, strong connections have been identified between certain universities, countries, and key concepts in publications on thinking skills. The leading role of National Cheng Kung University in the field particularly reflects East Asia's productivity in thinking skills research. Keyword analysis reveals that critical thinking has established itself as a central theme, while creative thinking and computational thinking concepts are on the rise. These key concepts suggest a change in trends within the research. Another notable finding is that countries such as Indonesia, the U.S., Turkey, China, Spain, and the U.K. are influential on a global scale due to their publication volume. These countries attract attention for their significant contributions to the field of thinking skills worldwide through their published works.

Author Contributions

The author declares that no other author has contributed to the study and that the author has read and approved the final version of the manuscript.

Ethical Declaration

This study does not require formal ethics committee approval, as it relies on anonymized data without involving direct participant interaction.

Conflict of Interest

The author declares that there is no conflict of interest with any institution or individual involved in the study.

Declaration of Generative AI Use

In this study, DeepL and ChatGPT were employed during the English language editing process to enhance the fluency of the text. All outputs generated by these tools were carefully reviewed and revised by the author. The author assumes full responsibility for the content of the manuscript.

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Appendix 1. PRISMA checklist.

SECTION and TOPIC	ITEM	CHECKLIST ITEM	LOCATION WHERE ITEM IS REPORTED
TITLE			
Title	1	Identify the report as a systematic review.	✓
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	✓
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	✓
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	✓
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	✓
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	✓
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	✓
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	✓
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	✓
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	✓ (publication year, author, citation count, etc.)
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Bias assessment is not conducted in bibliometric analyses.
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	R-Studio Biblioshiny.
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Measures such as risk ratio were not evaluated.
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Numerical data have been summarized; no meta-analysis was conducted.
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Numerical data have been summarized; no meta-analysis was conducted.
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Numerical data have been summarized; no meta-analysis was conducted.
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Numerical data have been summarized; no meta-analysis was conducted.
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	Numerical data have been summarized; no meta-analysis was conducted.
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	Numerical data have been summarized; no meta-analysis was conducted.

Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Publication bias has not been assessed.
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	No systematic analysis has been conducted to evaluate the reliability of the findings
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	✓
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	✓
Study characteristics	17	Cite each included study and present its characteristics.	✓
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Risk of bias assessment has not been performed.
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Due to the absence of a meta-analysis, relevant information could not be provided.
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Due to the absence of a meta-analysis, relevant results cannot be presented.
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Due to the absence of a meta-analysis, relevant results cannot be presented.
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	Due to the absence of a meta-analysis, relevant results cannot be presented.
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	Due to the absence of a meta-analysis, relevant results cannot be presented.
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Publication bias has not been assessed.
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Reliability assessment has not been performed.
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	✓
	23b	Discuss any limitations of the evidence included in the review.	✓
	23c	Discuss any limitations of the review processes used.	✓
	23d	Discuss implications of the results for practice, policy, and future research.	✓
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Bibliometric analyses generally do not require preregistration.
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	There is no pre-prepared protocol for this study.
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	There is no pre-prepared protocol for this study.
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	No financial support was received.
Competing interests	26	Declare any competing interests of review authors.	Since it is a single-author study, there is no conflict of interest
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	✓

From: 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. *BMJ* 2021;372: n71. doi: 10.1136/bmj. n71. This work is licensed under CC BY 4.0. To view a copy of this license, visit <https://creativecommons.org/licenses/by/4.0/>