

# The Evolution of Higher-Order Thinking Skills (HOTS) Research in Education: A Bibliometric Study

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## ABSTRACT

This study aims to examine the evolution of Higher-Order Thinking Skills (HOTS) research in education through a bibliometric approach. The study analyzes scientific publications indexed in major academic databases over a specific period using bibliometric techniques such as co-occurrence, overlay visualization, and density mapping through VOSviewer software. The results show that HOTS research has experienced significant development, with a primary focus on pedagogical aspects, particularly on students, learning strategies, and critical thinking. The co-occurrence analysis reveals that core themes such as higher-order thinking skills, students, and education dominate the research landscape, reflecting a significant focus on the learning process. Temporal visualization reveals a shift from basic educational concepts to more innovative approaches such as problem-based learning and technology-based learning. Recent trends demonstrate increasing attention to the integration of digital technologies, such as artificial intelligence and deep learning, in HOTS development. Meanwhile, the density analysis indicates that although traditional pedagogical themes remain dominant, new topics related to technology and assessment offer broad research opportunities. Overall, this study provides a comprehensive mapping of the intellectual structure and trends of HOTS research and suggests directions for future research in educational innovation and policy.

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## 1. INTRODUCTION

Education in the 21st century increasingly emphasizes developing students who are able to think critically, creatively, and analytically when facing complex problems [1], [2]. These competencies are often framed within the concept of Higher-Order Thinking Skills (HOTS), which refers to cognitive processes that go beyond memorization and basic understanding [3]. HOTS involve skills such as analyzing, evaluating, synthesizing,

and creating new knowledge from existing information. This idea stems from a taxonomy of educational objectives proposed by educational psychologists, which classifies thinking skills into hierarchical levels ranging from low-level to high-level processes [4], [5]. In modern educational discourse, the development of HOTS has become a primary goal because society needs individuals who are able to solve new problems, make

informed decisions, and adapt to rapid technological and social changes [6], [7].

The integration of HOTS into education systems has been significantly driven by global educational reforms. Many countries have revised their curricula to incorporate inquiry-based learning, problem-based learning, and other pedagogical strategies aimed at fostering deeper cognitive engagement. International assessments, such as those evaluating students' reasoning and problem-solving abilities, have also contributed to increased attention to higher-order thinking in the classroom. Educators and policymakers are increasingly recognizing that traditional teaching approaches emphasizing rote learning are insufficient to prepare students for complex, real-world challenges. Consequently, research on HOTS (Higher Order Thinking Skills) has expanded significantly, exploring areas such as instructional design, assessment methods, teacher competencies, and the role of technology in fostering higher-order thinking [8], [9].

Over the past few decades, scholarly interest in HOTS has grown across various disciplines in educational research. Studies have examined how teaching strategies such as collaborative learning, project-based learning, and digital learning environments can stimulate higher-order cognitive processes in students. Other research has focused on developing assessment instruments capable of measuring analytical and evaluative thinking rather than simply memorizing information. Furthermore, the rapid advancement of digital technology and the expansion of online learning environments have opened up new possibilities for developing HOTS (Higher Order Thinking Skills) through interactive simulations, adaptive learning systems, and data-driven instructional approaches. This diversification of research themes demonstrates that HOTS is not only a pedagogical concept but also a growing, multidisciplinary field of research [10], [11].

Despite the growing body of literature on HOTS, the development of this research field is not always systematically

mapped. Educational studies often focus on specific teaching strategies, subject areas, or educational levels without examining broader patterns of research development over time. As the number of publications increases, it becomes increasingly difficult for scholars to identify key research trends, influential authors, dominant themes, and emerging topics within the HOTS domain. Understanding these patterns is crucial because it allows researchers to evaluate how knowledge in this field has evolved, identify gaps in the literature, and determine potential directions for future research.

Bibliometric analysis offers a powerful methodological approach for examining the evolution of scientific research in a specific field. By analyzing publication data such as authorship patterns, citation networks, keywords, and research collaborations, bibliometric studies can reveal the intellectual structure and development trajectory of a research field. This approach has been widely used to explore trends in various educational topics, providing insights into how research communities are formed and how knowledge flows between institutions and countries. Therefore, applying bibliometric analysis to HOTS research can provide a comprehensive picture of how scholarly attention to higher-order thinking has evolved, which topics dominate the literature, and how research networks have evolved over time. Such insights are valuable not only for researchers but also for educators and policymakers seeking evidence-based guidance for improving educational practice.

Although research on Higher-Order Thinking Skills has grown rapidly in recent decades, the overall development and structure of this field of knowledge remains underexplored. Many studies investigate HOTS within specific contexts, such as specific subjects, teaching methods, or educational levels, but relatively few have attempted to chart the broader evolution of HOTS research across time, disciplines, and geographies.







Meanwhile, areas with green to blue colors indicate relatively less dense or still developing topics, such as artificial intelligence, deep learning, chatGPT, and approaches like problem-based learning and flipped classroom. This indicates that the integration of technology and learning innovation in the context of HOTS is a newer research direction

and still has significant potential for development. Furthermore, the emergence of terms such as "educational measurement" and "assessment" in areas with medium density indicates attention to HOTS evaluation, although it has not yet become a dominant focus.

**b. Citation Analysis**

Table 1. Most Cited Article

Citations	Author and Year	Title
866	[12]	A SWOT analysis of ChatGPT: Implications for educational practice and research
851	[13]	Education and thinking: The role of knowledge
686	[14]	Education for life and work: Developing transferable knowledge and skills in the 21st century
469	[15]	Development of systems thinking skills in the context of earth system education
435	[16]	Changing how and what children learn in school with computer-based technologies
396	[17]	Higher order thinking skills and low-achieving students: Are they mutually exclusive?
384	[18]	Problem-Based Learning
367	[19]	Purposely teaching for the promotion of higher-order thinking skills: A case of critical thinking
349	[20]	Problem solving by 5-6 years old kindergarten children in a computer programming environment: A case study
339	[21]	What factors facilitate teacher skill, teacher morale, and perceived student learning in technology-using classrooms?

Source: Scopus, 2026

**3.2 Discussion**

The discussion of the results of this bibliometric analysis indicates that research on Higher-Order Thinking Skills (HOTS) in education has developed significantly and has an increasingly complex intellectual structure. Based on the co-occurrence map, it is clear that core concepts such as higher-order thinking skills, students, critical thinking, and teaching have become the focus of attention in the literature. This confirms that HOTS development is still very much oriented towards the learning process and the role of students as the main subject. This dominance of pedagogical themes indicates that research focuses more on

how learning strategies can improve higher-order thinking skills, compared to other aspects such as policies or the education system at a macro level.

The cluster visualization results demonstrate the integration of pedagogical approaches with technological developments. The emergence of keywords such as artificial intelligence, deep learning, and chatGPT indicates that HOTS research is beginning to transform toward digitalized learning. This technological integration not only enriches learning methods but also opens up new opportunities for developing critical and creative thinking skills. However, based on the density map, these technology-

based topics are still at a lower density, indicating that this field is still relatively new and has not been explored in depth.

From a temporal perspective, overlay visualization analysis indicates a shift in research focus from conceptual aspects to more applicable and innovative implementations. In the initial phase, research focused more on basic educational concepts and learning characteristics. Subsequently, the focus shifted to developing learning strategies such as problem-based learning and flipped classrooms. In the most recent period, research trends have shifted toward utilizing digital technology to support HOTS. This shift reflects the dynamic development of education, which is adapting to changing times, particularly in facing the challenges of the digital era and the industrial revolution 4.0.

The analysis also shows that HOTS evaluation aspects, such as assessment and educational measurement, are beginning to receive attention, although they have not yet become a primary focus. This indicates a research gap that needs to be addressed, particularly in the development of evaluation instruments capable of validly and comprehensively measuring HOTS. Appropriate evaluation is key to ensuring that HOTS development occurs not only at the conceptual level but also can be measured and implemented effectively in educational practice. The

findings of this study confirm that HOTS research is in a transition phase toward a more integrative, innovative, and technology-based approach. Nevertheless, significant opportunities remain for research development, particularly in deeper technology integration, strengthening evaluation methods, and exploring more diverse educational contexts.

#### 4. CONCLUSION

Based on the results of the bibliometric analysis, it can be concluded that research on Higher-Order Thinking Skills (HOTS) in education has developed dynamically with an increasingly complex and multidisciplinary scientific structure. The main focus of research is still dominated by pedagogical aspects that emphasize the role of students, the learning process, and the development of critical thinking, but is gradually shifting towards the integration of technologies such as artificial intelligence and digital learning innovations. Furthermore, although attention to HOTS evaluation is starting to increase, this aspect still requires further strengthening. The evolution of HOTS research shows a direction that is increasingly adaptive to the demands of 21st-century education, while also opening up broad opportunities for further research in the development of more comprehensive evaluation methods, technologies, and systems.

#### REFERENCE

- [1] A. Dilekçi and H. Karatay, "The effects of the 21st century skills curriculum on the development of students' creative thinking skills," *Think. Ski. Creat.*, vol. 47, p. 101229, 2023.
- [2] F. I. Muzaki, "Challenges in 21st Century of Teaching Critical Thinking: Navigating Creativity Challenges in Elementary Schools," *WIDYANTARA*, vol. 2, no. 1, pp. 11–21, 2024.
- [3] T. Siregar, "Balancing Higher-and Lower-Order Thinking Skills: An Analysis of Lecturers' Pedagogical Practices in Higher Education," *Available SSRN 5590290*, 2025.
- [4] Z. Saeed, "Bloom's Taxonomy in Pakistani School Education: A Pathway to Enhance Higher Order Thinking Skills (HOTS)," *Crit. Rev. Soc. Sci. Stud.*, vol. 3, no. 1, pp. 856–863, 2025.
- [5] A. Finansu, J. Hidayah, and M. Fauziah, "Lots And Hots Analysis In Exercise Of English Textbook At Seventh Grade Of Smp It Rabbi Radhiyya." Institut Agama Islam Negeri Curup, 2025.
- [6] A. Ragab, A. Kaid, and A. K. Sayed, "Enhancing higher order thinking skills (hots) in education: Strategies and outcomes," *TOFEDU Futur. Educ. J.*, vol. 3, no. 5, pp. 1488–1499, 2024.
- [7] S. Setyarini, H. Salim, and P. Purnawarman, "Higher-Order Thinking Skills HOTS-based literacy media: An

- innovative learning strategy to promote the secondary students' social awareness," in *Forum for Linguistic Studies (Transferred)*, 2023, vol. 5, no. 2, p. 1706.
- [8] H. X. Vu, "Leveraging technology for higher-order thinking development: Instructional design strategies in higher education," *Int. J. Technol. Learn.*, vol. 32, no. 2, p. 25, 2025.
- [9] A. R. Yadav and C. K. Singh, "An Exploration of Teaching Strategies That Promote Problem-Solving and Higher-Order Thinking Skills," *Int. J. Eng. Sci. Humanit.*, vol. 16, no. 1, pp. 100–109, 2026.
- [10] K. Sivakumar and M. Boon, "A preliminary higher order thinking skills (HOTS) framework for interdisciplinary problem solving and scientific research (IDPSSR) in engineering science education," *Eur. J. Eng. Educ.*, pp. 1–34, 2026.
- [11] Y. Jing, C. Wang, Z. Chen, S. Shen, and R. Shadiey, "A bibliometric analysis of studies on technology-supported learning environments: Hot topics and frontier evolution," *J. Comput. Assist. Learn.*, vol. 40, no. 3, pp. 1185–1200, 2024.
- [12] M. Farrokhnia, S. K. Banihashem, O. Noroozi, and A. Wals, "A SWOT analysis of ChatGPT: Implications for educational practice and research," *Innov. Educ. Teach. Int.*, vol. 61, no. 3, pp. 460–474, 2024.
- [13] R. Glaser, "Education and thinking: The role of knowledge," *Am. Psychol.*, vol. 39, no. 2, p. 93, 1984.
- [14] D. T. Knowledge, "Education for life and work," 2012.
- [15] O. B. Assaraf and N. Orion, "Development of system thinking skills in the context of earth system education," *J. Res. Sci. Teach. Off. J. Natl. Assoc. Res. Sci. Teach.*, vol. 42, no. 5, pp. 518–560, 2005.
- [16] J. M. Roschelle, R. D. Pea, C. M. Hoadley, D. N. Gordin, and B. M. Means, "Changing how and what children learn in school with computer-based technologies," *Futur. Child.*, pp. 76–101, 2000.
- [17] A. Zohar and Y. J. Dori, "Higher order thinking skills and low-achieving students: Are they mutually exclusive?," *J. Learn. Sci.*, vol. 12, no. 2, pp. 145–181, 2003.
- [18] W. Hung, D. H. Jonassen, and R. Liu, "Problem-based learning," in *Handbook of research on educational communications and technology*, Routledge, 2008, pp. 485–506.
- [19] B. Miri, B.-C. David, and Z. Uri, "Purposely teaching for the promotion of higher-order thinking skills: A case of critical thinking," *Res. Sci. Educ.*, vol. 37, no. 4, pp. 353–369, 2007.
- [20] G. Fessakis, E. Gouli, and E. Mavroudi, "Problem solving by 5–6 years old kindergarten children in a computer programming environment: A case study," *Comput. Educ.*, vol. 63, pp. 87–97, 2013.
- [21] A. L. Baylor and D. Ritchie, "What factors facilitate teacher skill, teacher morale, and perceived student learning in technology-using classrooms?," *Comput. Educ.*, vol. 39, no. 4, pp. 395–414, 2002.