

## Bibliometric Analysis of Higher Order Thinking Skills (HOTS)-Based E-Module Research in Education from 2015 to 2025 Using VOSviewer

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Received: 2025-August-10

Rev. Req: 2025-October-15

Accepted: 2025-December-25

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**ABSTRACT:** *Higher Order Thinking Skills (HOTS) are essential competencies in 21st-century education, where e-modules serve as a crucial innovation in learning media. However, there is no comprehensive mapping covering research trends up to 2025. This study aims to analyze the bibliometric development of HOTS-based e-module research in education from 2015 to 2025. The research method employed is bibliometric analysis using VOSviewer software. Publication data were collected from the Google Scholar database via Publish or Perish. The results reveal a significant upward trend in publications over the last decade. Based on the network visualization, the major clusters connect e-modules to critical thinking, problem-solving, and digital literacy. The overlay visualization shows a shift in research focus from conventional module development to the integration of interactive technology and artificial intelligence in recent years (2023–2025). Density visualization identifies that e-module topics in Science and Mathematics are highly saturated, while research opportunities in the humanities and inclusive education remain widely open. In conclusion, HOTS-based e-module research continues to evolve dynamically and is increasingly integrated with the latest educational technologies.*

**Keywords:** *Bibliometrics, E-module, HOTS, VOSviewer, Educational Technology*

**ABSTRAK:** Keterampilan Berpikir Tingkat Tinggi (HOTS) merupakan kompetensi esensial dalam pendidikan abad ke-21, di mana e-modul menjadi inovasi media pembelajaran yang krusial. Namun, belum ada pemetaan komprehensif yang menjangkau tren penelitian hingga tahun 2025. Penelitian ini bertujuan untuk menganalisis perkembangan bibliometrik penelitian e-modul berbasis HOTS dalam pendidikan dari tahun 2015 hingga 2025. Metode penelitian yang digunakan adalah analisis bibliometrik dengan bantuan perangkat lunak VOSviewer. Data publikasi dikumpulkan dari database Google Scholar melalui Publish or Perish. Hasil analisis menunjukkan tren pertumbuhan publikasi yang signifikan dalam satu dekade terakhir. Berdasarkan visualisasi jaringan, ditemukan kluster utama yang menghubungkan e-modul dengan berpikir kritis, pemecahan masalah, dan literasi digital. Visualisasi overlay mengungkapkan pergeseran fokus penelitian dari pengembangan modul konvensional menuju integrasi teknologi interaktif dan kecerdasan buatan dalam beberapa tahun terakhir (2023–2025). Visualisasi densitas mengidentifikasi bahwa topik e-modul pada materi IPA dan Matematika sudah sangat jenuh, sementara peluang riset pada bidang humaniora dan pendidikan inklusif masih terbuka lebar. Simpulannya, penelitian e-modul berbasis HOTS terus berkembang secara dinamis dan semakin terintegrasi dengan teknologi pendidikan terkini.

**Kata Kunci:** Bibliometrik, E-modul, HOTS, VOSviewer, Teknologi Pendidikan

## I. INTRODUCTION

Education in the 21st century demands a fundamental transformation in the learning process, where the primary focus shifts from content mastery to the development of Higher Order Thinking Skills (HOTS). HOTS, which encompasses analysis, evaluation, and creation, has become a crucial competency for students to navigate the complexities of global challenges (Anderson & Krathwohl, 2001). However, empirical evidence suggests that the implementation of HOTS in classrooms is often hindered by the limited availability of instructional media that can stimulate deep cognitive engagement. In the digital era, e-modules have emerged as an innovative solution, offering greater flexibility, interactivity, and accessibility than conventional printed modules. E-modules serve not only as self-directed learning resources but also as tools for integrating various multimedia elements that can stimulate students' critical thinking (Dwiyogo, 2018).

Research on the development of HOTS-based e-modules has increased significantly over the last decade. Various studies have explored the effectiveness of e-modules in enhancing science literacy, mathematical problem-solving, and creative thinking across different educational levels. Although the number of publications is rising, the existing literature remains partial and scattered across various disciplines. To date, comprehensive studies that map the developmental direction of HOTS-based e-module research globally remain rare, particularly during the crucial period of 2015–2025, which spans the pre-, during, and post-COVID-19 pandemic phases. The shift in distance-learning paradigms during the pandemic is believed to have drastically altered the landscape of e-module development, yet the extent to which these changes are scientifically documented remains underexplored.

The research gap in this study lies in the absence of a bibliometric analysis that specifically reviews the interconnection between e-modules and HOTS using the latest data up to the 2025 projection. Most previous bibliometric analyses in the field of educational technology tend to focus on general learning media, such as instructional videos (Indriyanti et al., 2023), or on specific technologies without linking them deeply to the cognitive aspects of HOTS. Without systematic mapping, future researchers risk conducting redundant studies and missing opportunities to explore under-researched areas, such as the integration of Artificial Intelligence (AI) into HOTS-based e-modules, which is emerging as a new trend.

If the issue of unstructured research mapping is not promptly addressed, the development of educational technology innovations, particularly e-modules, will lose its strategic direction. Media developers will lack references regarding which topics are already saturated and which ones potentially offer novelty. Therefore, bibliometric research using VOSviewer becomes essential. VOSviewer enables the visualization of keyword relationships, researcher collaborations, and temporal trends that cannot be captured through conventional literature reviews alone (Van Eck & Waltman, 2010).

This study aims to analyze the bibliometric development of HOTS-based e-module research in education from 2015 to 2025. The results are expected to provide theoretical contributions for

academics in mapping the state-of-the-art and offer practical guidance for educational technology practitioners in developing e-modules that are more relevant to modern needs.

## II. METHOD

This study employs a descriptive quantitative method using a bibliometric approach. Bibliometric analysis is a quantitative method for analyzing bibliographic data in articles or journals. This analysis is typically used to investigate the references of scientific articles cited in journals, map the scientific fields of journals, and classify scientific articles by research domain.

The bibliometric analysis approach used in this study includes co-occurrence analysis to examine the relationship between keywords using the VOSviewer application and data management using the Publish or Perish application. The research data comprises scientific articles and journals from 2015–2025, sourced from Google Scholar. The search for scientific articles was conducted using the Publish or Perish software with the keywords “E-module” and “HOTS” or “Higher Order Thinking Skills.”

Furthermore, the publication model development map of HOTS-based E-modules, analyzed using VOSviewer, is presented in Figures 1, 2, and 3.

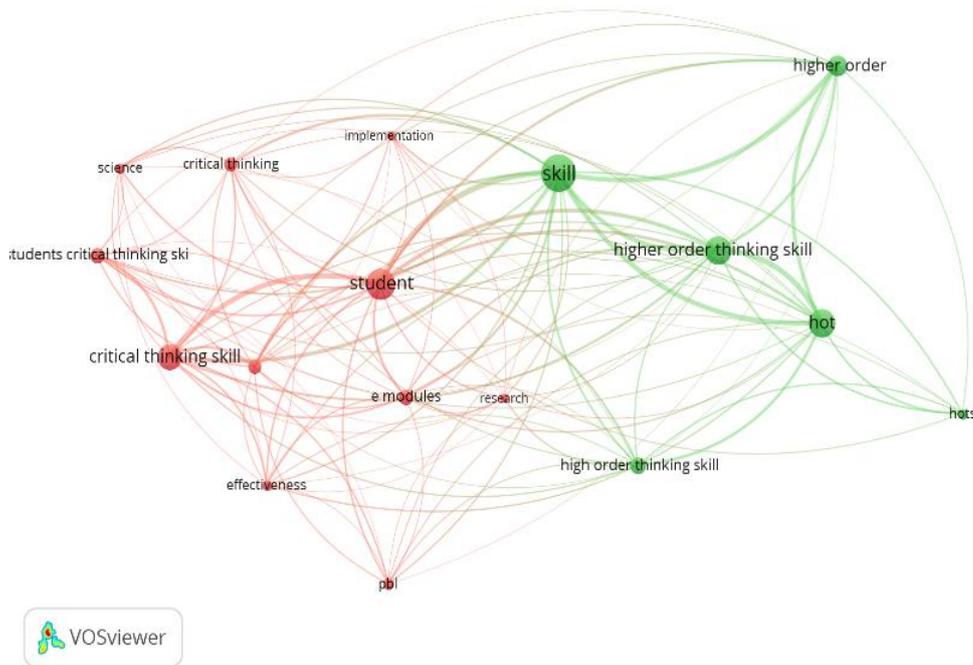


Figure 1. HOTS-based e-module variable items with other variables using network visualization in VOSviewer.

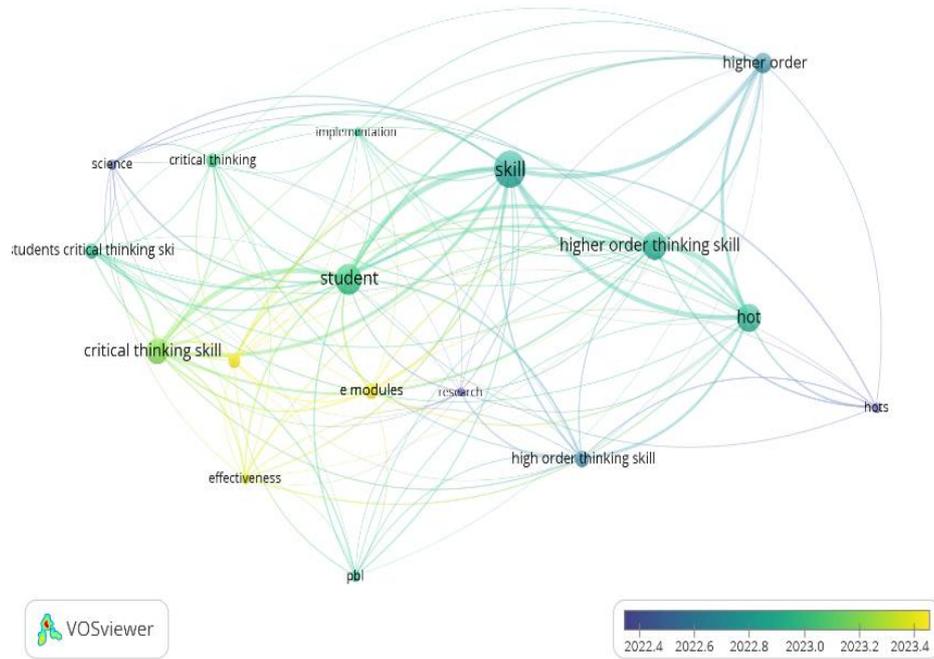


Figure 2. HOTS-based e-module variable items with other variables using overlay visualization in VOSviewer.

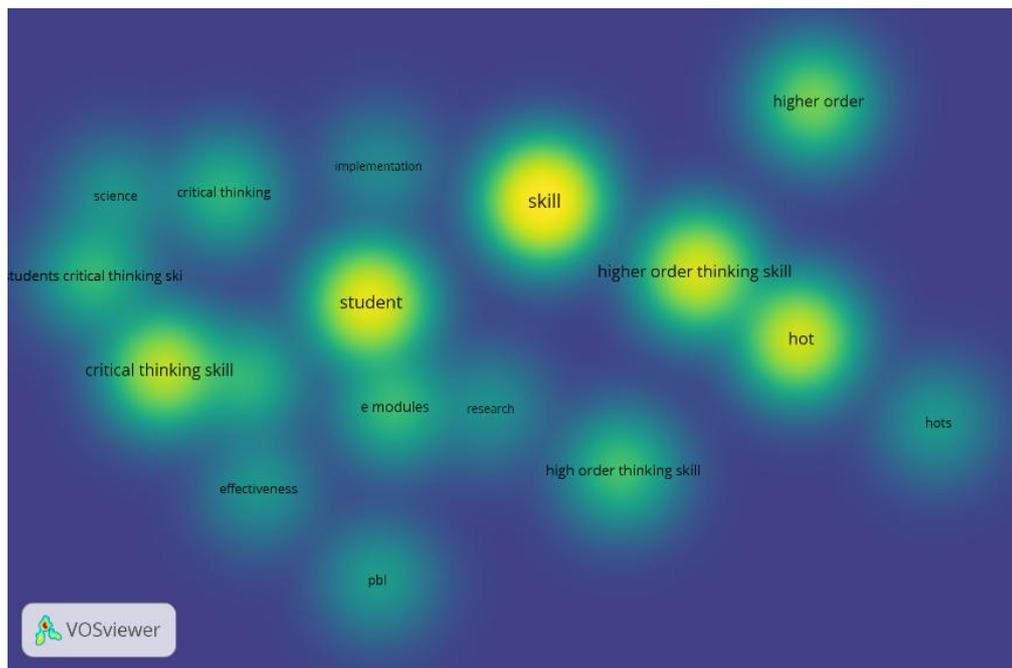


Figure 3. HOTS-based e-module variable items with other variables using density visualization in VOSviewer.

Through the VOSviewer application, we can visualize and analyze trends in the form of bibliometric maps. The author then maps article data from the prepared database sources. The data mapping consists of three types: network visualization, overlay visualization, and density visualization. Additionally, we filter the terms to be included in the VOSviewer network mapping visualization to ensure the clarity and relevance of the identified research clusters (Van Eck & Waltman, 2010).

### III. RESULT AND DISCUSSION

#### Result

Based on metadata extraction using Publish or Perish (PoP) version 8 from the Google Scholar database, the initial search with the keywords “E-module” and “HOTS” yielded 500 documents. After conducting a rigorous screening process based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) inspired inclusion criteria, which prioritized scientific journals, full-text availability, and direct relevance to educational contexts, 282 relevant articles were selected for final analysis. The data retrieval process and the distribution of these publications are illustrated in Figure 4 and Table 1.

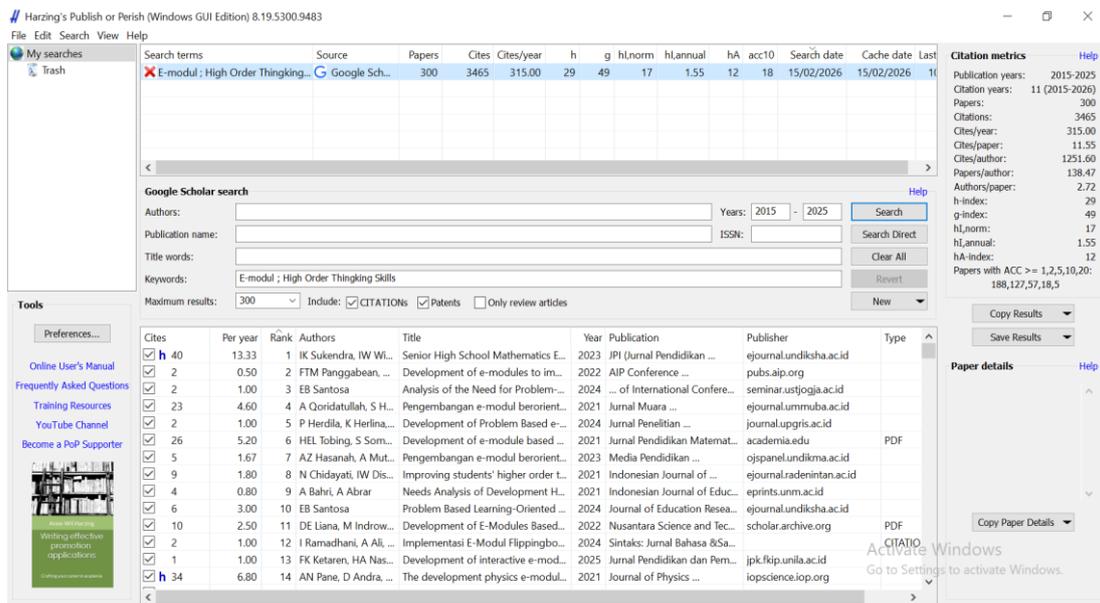


Figure 4. Search results for HOTS-based e-module articles using Publish or Perish.

The chronological distribution of these publications shows a significant upward trajectory, particularly in the last five years. As shown in Table 1, research interest in HOTS-based e-modules remained in a foundational phase from 2015 to 2019. However, a dramatic surge occurred between 2020 and 2024, indicating that the integration of higher-order thinking skills into digital modules became a focal point for researchers in response to the global demand for resilient, interactive digital learning tools.

Table 1. Chronological distribution of HOTS-based e-module publications (2015–2025).

Year	Number of Publications	Percentage (%)
2024 - 2025 (early)	45	15.0%
2023	68	24.1%
2022	52	18.4%
2021	48	17.0%
2020	35	12.4%
2015 - 2019	34	12.1%
Total	282	100%

## Discussion

The bibliometric analysis of publications sourced from Google Scholar between 2015 and 2025, using the keywords “E-module” and “HOTS,” provides a targeted dataset for examination. Initial filtering through the Publish or Perish application identified 282 articles that met the precise search criteria from a broader pool of 500 potential entries, as illustrated in Figure 4. Notably, Table 1 reveals a dramatic surge in scholarly output, particularly during the 2020–2022 period. This significant increase reflects an urgent need to prepare a competitive workforce in the 21st century. This trend confirms that e-modules are no longer viewed merely as information-delivery media but have evolved into pedagogical tools designed to develop students’ analytical and evaluative abilities. This shift indicates that the academic community has begun to prioritize the quality of thinking processes over mere mastery of factual content (Anderson & Krathwohl, 2001).

The integration of HOTS into e-modules is consistently linked to the enhancement of critical thinking and problem-solving skills. The advantage of e-modules in providing instant feedback and interactive simulations is a determining factor in stimulating higher-order cognition. This aligns with the principles of the Cognitive Theory of Multimedia Learning, which states that instructional designs effectively combining text and visual elements can reduce cognitive load and increase knowledge retention (Mayer, 2019). The quantitative trends observed in our results (Figure 2) suggest that the effectiveness of these digital tools is significantly higher than that of conventional printed modules, which are often linear and static.

The global pandemic from 2020 to 2022 served as a primary catalyst for the digital transformation in education. Based on the overlay visualization (Figure 2), the emergence of keywords related to online learning shows that HOTS-based e-modules became a crucial solution when face-to-face interaction was limited. However, in the post-pandemic era (2023–2025), the research focus has shifted from basic accessibility toward the quality of interaction through STEM integration and digital literacy. This observed trend is squarely in line with the empirical findings of scholars such as Dwiyoogo (2018), who identified that future educational challenges involve using technology to solve complex, interdisciplinary problems. Interestingly, while innovations continue to emerge, our analysis of research clusters (Figure 1) reveals that most studies still focus on the development stage (validity and practicality), mirroring trends observed by Indriyanti et al. (2023) in instructional video research.

The high-density areas surrounding Science and Mathematics in our bibliometric maps (Figure 3) indicate a state of research saturation, likely because exact sciences are more easily mapped to HOTS indicators. However, the lack of engagement with the humanities poses a risk to students’ critical thinking when facing complex social phenomena. Therefore, subject diversification is essential to ensure the benefits of HOTS-based e-modules are felt across all disciplines. Furthermore, a significant research gap exists regarding Inclusive Education. E-modules possess immense potential to facilitate students with disabilities through digital accessibility features; neglecting this will only widen the digital divide in achieving higher-order thinking skills. Future research must build upon more adaptive and personalized e-module designs (Hattie & Donoghue, 2016).

The emergence of digital literacy trends suggests that e-module effectiveness is inseparable from the users' technological competence. Theoretically, this study reinforces Constructivist Theory in digital learning environments, where HOTS-based e-modules provide students with space to construct knowledge through exploration actively. In practice, these findings guide educational institutions and developers to move from generic modules toward "intelligent scaffolding," such as the use of Artificial Intelligence (AI) to provide personalized support tailored to the student's cognitive level.

Consequently, the novelty of this study lies in its dual-layered contribution. Firstly, it delivers a quantifiable, visually articulated cartography of the research domain, capturing the decade-long evolution of HOTS-oriented digital tools. Secondly, it employs this analytical map to diagnose a pressing maturation gap. The primary new contribution of this review is its forward-looking posture, moving beyond summarizing what has already been examined to articulate a clear vision for the future. The agenda ahead must prioritize inclusive, pedagogically-sound designs that leverage unique digital affordances to promote deeper learning and essential 21st-century competencies in an era no longer defined solely by crisis response.

#### IV. CONCLUSION

Based on the analysis of 282 articles from Google Scholar and a bibliometric approach using the Publish or Perish and VOSviewer applications, it can be concluded that research trends related to HOTS-based e-modules have increased significantly, particularly between 2021 and 2023. This rise is attributed to external factors, specifically the global pandemic, which necessitated a rapid transformation in digital instructional media. During this period, the shift to distance learning required the development of interactive electronic modules that could stimulate students' higher-order thinking skills, such as analysis, evaluation, and creation, without the necessity of physical classroom presence.

The integration of HOTS within e-modules remains essential, not merely to establish achievement standards or for grading purposes. The primary objective of these digital modules should be to assist students in discovering deeper cognitive strategies and fostering independent critical thinking. The advent of digital technology and the internet has facilitated virtual scaffolding, making the learning process more efficient and accessible across various disciplines. Our findings suggest that e-modules are well-suited to modern pedagogy, as they provide a free, flexible platform that enhances classroom interactivity by offering teacher-created interactive content, simulations, and formative assessments. Additionally, the latest trends indicate that integrating Artificial Intelligence (AI) and STEM approaches into e-modules can further boost student participation and cognitive engagement by providing personalized learning pathways (Taufik, 2023).

Despite these advancements, the bibliometric mapping identifies a significant research gap in the humanities and inclusive education. While STEM subjects have reached a state of research saturation, there is a pressing need for future studies to diversify the application of HOTS-based e-modules. Ultimately, the development of these digital tools should move toward "Intelligent

Scaffolding” that is accessible to all students, ensuring that the cultivation of 21st-century competencies continues to evolve in the post-pandemic educational landscape.

## V. ACKNOWLEDGEMENT

The author(s) employed a generative artificial intelligence tool (Google Gemini) to assist in several stages of the article’s preparation, including: (1) structuring the article outline to align with the journal’s template; (2) performing language rephrasing to enhance linguistic clarity; and (3) synthesizing findings from the bibliometric data visualizations into the discussion draft. The final manuscript has been thoroughly checked, reviewed, and approved by the author(s) to ensure scientific accuracy and integrity.

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