AG EDITOR

Bibliometric Analysis Of The Use Of Learning Videos In Science Education: Trends, Impact, And Future Potential

Análisis bibliométrico del uso de videos de aprendizaje en la educación científica: tendencias, impacto y potencial futuro

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ABSTRACT

Introduction: instructional videos play a vital role in science education because they make abstract concepts more understandable and engaging. However, few bibliometric studies have mapped their global research development, creating a gap in understanding trends, impact, and future directions. This study addresses that gap to highlight the importance of video-based learning as a transformative educational tool.
Method: a bibliometric analysis was conducted using 130 documents indexed in Scopus between 1971 and 2024. The articles were identified through Publish or Perish, filtered for relevance, and analyzed using VOSviewer. Data were examined across publication trends, affiliations, country contributions, author keywords, collaborations, citation impact, and emerging themes.
Results: publications increased sharply after 2010, reflecting growing attention to technology-supported science education. The United States, Indonesia, and Australia were the leading contributors, with New York University and Stanford University as dominant institutions. Common keywords included teaching, education, and science learning. Collaboration networks showed strong links among authors such as Goldman and Pea. The most cited article emphasized the methodological and ethical challenges of video research. Future potential areas include AI-driven personalization, gamification, VR/AR-based learning, teacher professional development, collaborative learning, and cross-country comparisons.
Conclusions: instructional videos have become a critical component of science education, with significant contributions across countries and institutions. The findings underline their transformative impact on teaching and learning while identifying promising directions for future research. This study contributes to filling gaps in the literature and guiding scholars toward innovative, technology-integrated approaches to science education.

Keywords: Bibliometric Analysis; Learning Videos; Science Education.

RESUMEN

Introducción: los videos instructivos juegan un papel vital en la educación científica porque hacen que los conceptos abstractos sean más comprensibles y atractivos. Sin embargo, pocos estudios bibliométricos han mapeado su desarrollo de investigación global, creando una brecha en la comprensión de las tendencias, el impacto y las direcciones futuras. Este estudio aborda esa brecha para resaltar la importancia del aprendizaje basado en video como una herramienta educativa transformadora.

Método: se realizó un análisis bibliométrico utilizando 130 documentos indexados en Scopus entre 1971 y 2024. Los artículos se identificaron a través de Publish or Perish, se filtraron por relevancia y se analizaron mediante VOSviewer. Los datos se examinaron a través de tendencias de publicación, afiliaciones, contribuciones de países, palabras clave de autores, colaboraciones, impacto de citas y temas emergentes.

Resultados: las publicaciones aumentaron considerablemente después de 2010, lo que refleja la creciente atención a la educación científica apoyada por la tecnología. Estados Unidos, Indonesia y Australia fueron los principales contribuyentes, con la Universidad de Nueva York y la Universidad de Stanford como instituciones dominantes. Las palabras clave comunes incluyeron enseñanza, educación y aprendizaje de ciencias. Las redes de colaboración mostraron fuertes vínculos entre autores como Goldman y Pea. El artículo más citado enfatizó los desafíos metodológicos y éticos de la investigación en video. Las áreas potenciales futuras incluyen la personalización impulsada por IA, la gamificación, el aprendizaje basado en VR/AR, el desarrollo profesional de los maestros, el aprendizaje colaborativo y las comparaciones entre países.

Conclusiones: los videos instructivos se han convertido en un componente crítico de la educación científica, con contribuciones significativas en todos los países e instituciones. Los hallazgos subrayan su impacto transformador en la enseñanza y el aprendizaje, al tiempo que identifican direcciones prometedoras para futuras investigaciones. Este estudio contribuye a llenar los vacíos en la literatura y guiar a los académicos hacia enfoques innovadores e integrados en tecnología para la educación científica.

Palabras clave: Análisis Bibliométrico; Videos de Aprendizaje; Educación Científica.

INTRODUCTION

Technology is a major driver in transforming education worldwide. Among digital innovations, instructional videos stand out for their ability to simplify complex concepts and enhance student comprehension. In science education, which often deals with complex processes, videos provide visual representations that help students connect theoretical knowledge with real-world applications.[1,2,3] With a strong impact on science education, which often involves abstract concepts and complex processes, instructional videos offer visual representations that aid in student understanding.[4,5,6,7,8] In many cases, videos allow students to see real-time applications of the theories they are learning, linking theoretical aspects to the real world.[1,9,10] The use of instructional videos has increased alongside the global shift toward digital learning tools.[11,12] Previous studies confirm that multimedia resources, including videos, address diverse learning needs and improve understanding of complex scientific ideas.[13] For example, Li et al.[14] Found that students in biology courses supported by videos outperformed peers in traditional lectures. This evidence indicates that instructional videos can shift learning from passive listening to active engagement, especially in STEM disciplines where visual representation is critical.

Despite these advantages, several challenges remain. Issues of access, content quality, and integration into pedagogy limit their effectiveness.[15,16,17] A review by Noetel et al.[18] Concluded that while videos enhance short-term retention, their long-term benefits depend on design and learner interaction. Furthermore, the digital divide in developing countries restricts equitable access, raising questions about inclusivity and sustainability in video-based education.[18,19,20,21,22] These challenges necessitate further research to optimize video use and ensure inclusivity, especially in resource-constrained environments. The theoretical foundation for video use builds on cognitive load theory and dual coding theory, both of which emphasize the synergy of visual and auditory information.[23,24,25] Recent studies extend these principles, showing that shorter and structured videos reduce cognitive overload and improve performance in subjects such as chemistry.[26,27] For example, Guo S et al.[28] Found that shorter, well-structured videos significantly improved student performance in chemistry courses. At the same time, emerging technologies such as artificial intelligence and virtual reality offer opportunities for personalized and immersive learning experiences.

Over the past two decades, the education sector has undergone significant changes regarding the implementation of videos. Initially, videos were supplementary resources in classrooms.[29,30,31,32,33] With the advent of digital platforms and mobile access, they became central to online and blended learning models.[34] Furthermore, VR-based videos have been shown to facilitate a deeper understanding of abstract topics like molecular structures.[35] Currently, instructional videos support not only student learning but also teacher professional development and collaborative learning communities.[36] This evolution illustrates their expanding role in shaping modern education.

While bibliometric analyses exist for e-learning and educational technology, few studies have focused specifically on instructional videos in science education.[37,38,39,40] The lack of comprehensive mapping leaves gaps in understanding global contributions, collaboration patterns, and long-term impacts on learning outcomes.[41,42,43] Therefore, this study conducts a bibliometric analysis of instructional video research in science education, using the Scopus database as the primary source.[44,45,46,47] The objective is to identify publication trends,

affiliations, country-based contributions, author keywords, collaborations, citation impacts, and directions for future research.

Despite the growing body of research on digital learning and e-learning systems, the specific role of instructional videos in science education remains underexplored.[48,49] Previous studies have not sufficiently addressed how videos contribute to students' long-term understanding, knowledge retention, and critical thinking development across different contexts.[50,51,52] This gap highlights the need for a comprehensive overview that captures both the progress achieved and the directions for future inquirí.

This study aims to present a comprehensive bibliometric analysis related to the use of instructional videos in science education, focusing on aspects such as: identification of publication trends, affiliations, country-based analysis, author keywords, author collaboration analysis, citation impact analysis, and the future potential of using instructional videos in science education. Therefore, the purpose of this study is to provide a broad bibliometric analysis of instructional video research in science education. The study seeks to clarify global publication trends, identify the main contributors, and highlight emerging areas of innovation. By doing so, it contributes to a deeper understanding of how instructional videos support the advancement of science education and points toward opportunities for future development.

METHOD

Type of Study

This research is a non-observational, descriptive bibliometric study. It focuses on analyzing patterns and trends in published scientific literature without direct intervention in the observed phenomena. The approach is appropriate because the objective is to map the development and future directions of instructional video research in science education.[53,54,55,56]

Universe and Sample

The universe of the study consists of all publications indexed in the Scopus database that address the use of videos in science education.[57,58,59,60] Using a structured query string (Title (learning OR teaching) AND Title (video OR videos) AND Title (science)), the search yielded 130 documents published between 1971 and 2024. These documents, which include journal articles, conference papers, reviews, book chapters, and research notes, represent the sample analyzed in this study.[61,62,63]
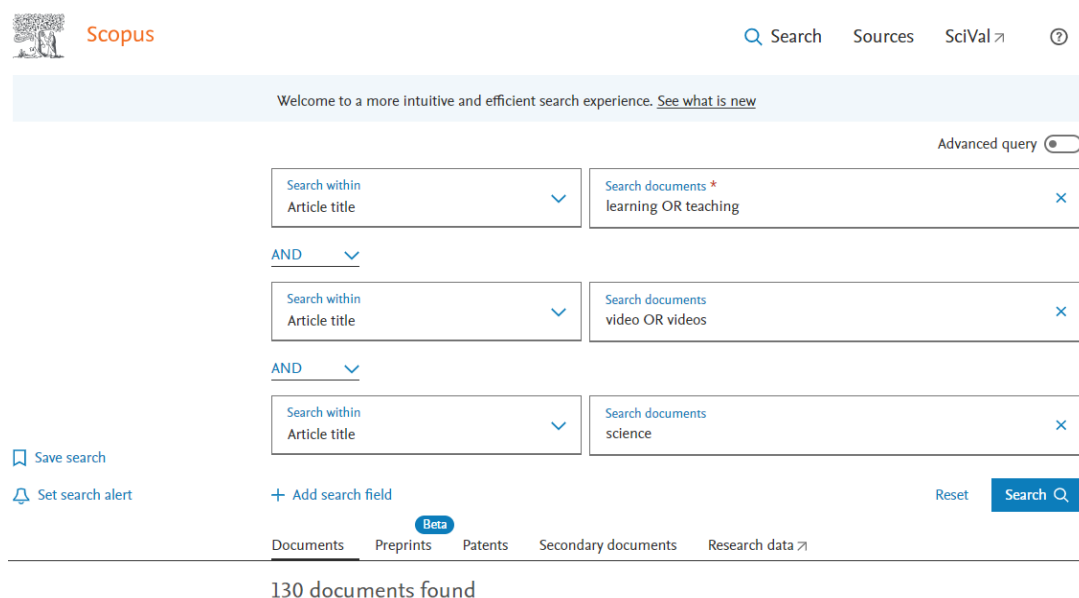

Figure 1. Screenshot of the search display in the Scopus database[64]

The search was conducted using the following query: (Title (learning OR teaching) AND Title (video OR videos) AND Title (science)). This query is designed to capture publications focused on videos used in the process of teaching and learning, with a strong impact on science education. The search procedure carried out on September 16, 2024, resulted in 130 documents, published between 1971 and 2024. This wide time frame allows for a comprehensive analysis of long-term trends in the use of instructional videos in the field of science. The publications include various document types, including journal articles and conference papers, reviews, book chapters, and research notes.

Variables
The analysis focused on bibliometric variables commonly used in mapping studies, including:
Publication trends (year of publication, growth over time).
Authorship and affiliations (authors, institutions, countries).
Keywords (frequency, co-occurrence networks).
Collaboration networks (co-authorship clusters).
Citation impact (most cited works, influential authors).

Data Collection and Processing
The data were retrieved from Scopus in September 2024 using the Publish or Perish software to ensure accuracy and export completeness. After collection, the records were filtered to exclude duplicates and irrelevant works not directly related to science education. Metadata were refined to standardize author names, keywords, and affiliations. The cleaned dataset was then analyzed with VOSviewer to generate visualizations of keyword co-occurrences, citation networks, and author collaborations. Descriptive statistics were applied to identify trends and distributions.

Ethical Standards
This study did not involve human subjects or personal data. All data were obtained from the Scopus database, a publicly accessible academic source. Ethical standards were followed by properly citing all references and ensuring transparency in data handling and reporting.

Bibliographic Completeness
To include only relevant publications in the analysis, the documents underwent a review process that removed duplicates and checked their relevance to instructional video research in science education. Publications unrelated to the field or employing videos for non-pedagogical purposes were excluded. This procedure ensured the accuracy and validity of the bibliometric dataset.

Bibliometric Analysis
The data collection and processing followed a structured procedure. First, metadata of publications were retrieved from Scopus in September 2024 using a defined query string. Second, duplicates and irrelevant records were removed to ensure accuracy. Third, descriptive statistics were applied to determine annual publication growth, distribution by country, and institutional contributions. Fourth, bibliometric techniques were implemented using VOSviewer, which generated visualizations of keyword co-occurrence, co-authorship networks, and citation patterns.[65,66,67,68,69,70] This combination of statistical summaries and network mapping allowed the identification of trends, research hotspots, and collaboration structures. The procedures provided both quantitative and visual insights, ensuring a comprehensive understanding of the evolution of instructional video research in science education.[41,44,71,72]

RESULTS
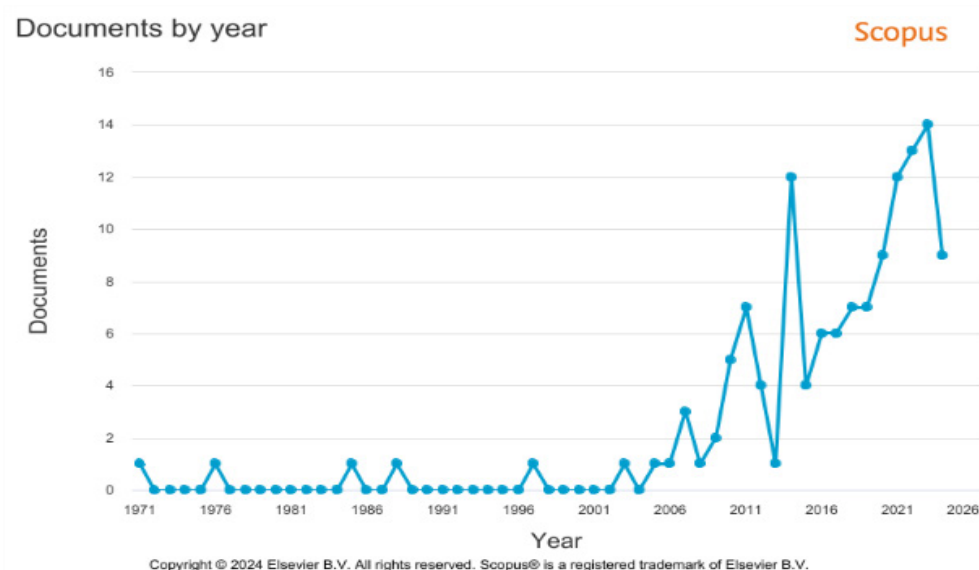**Publication Trends**

Figure 2. Document Diagram by Year

The annual number of publications on instructional videos in science education, based on Scopus data (figure 2), shows a gradual increase between 1971 and 2006. After 2010, the output rose more sharply, with fluctuations between 2011 and 2016, reaching a peak of 14 documents in 2012.

From 2017 onward, the number of publications continued to increase, peaking at 15 documents in 2021. Overall, the results demonstrate a clear upward trend in research output during the last decade.

Analysis Based on Affiliations

The analysis of author affiliations highlights the role of leading institutions in advancing research on instructional videos in science education. As shown in figure 3, New York University and Stanford University emerge as the most productive contributors, each with multiple publications in the field. Other institutions from diverse regions also appear in the dataset, reflecting the global scope of this research area. The presence of universities from North America, Europe, and Asia indicates that interest in instructional videos is not limited to one geographical region but represents a broad academic movement within science education.
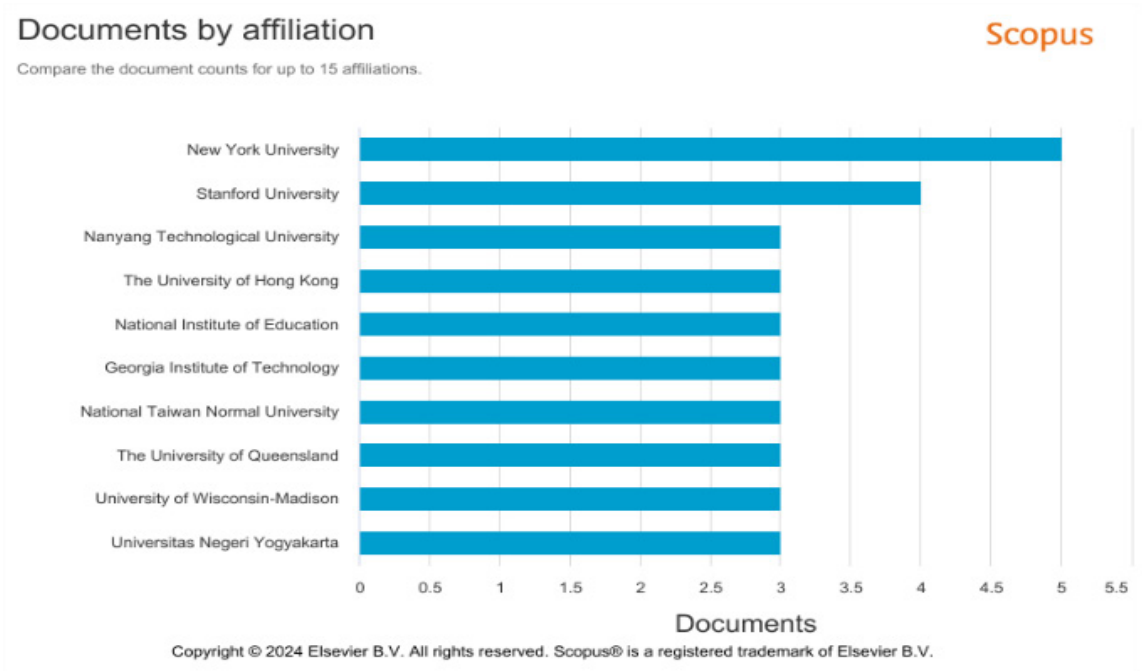
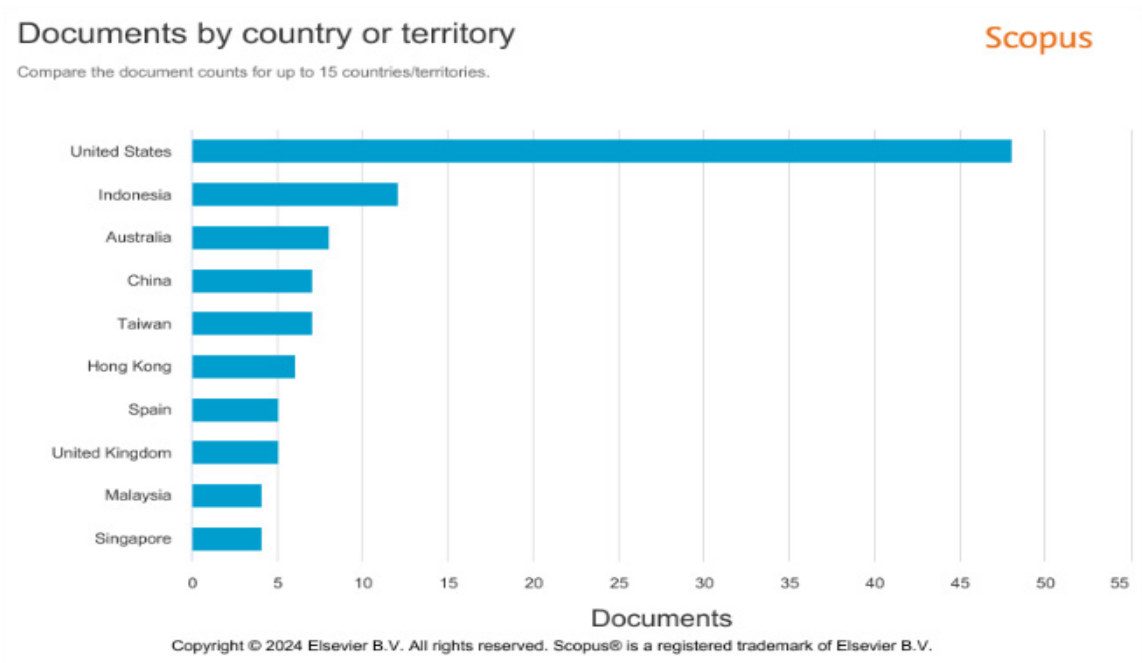**Figure 3.** Document Diagram by Affiliation

Figure 4. Document Diagram by Country

The inclusion of Universitas Negeri Yogyakarta among the affiliations shows that contributions to research on instructional videos extend beyond developed countries. Indonesia appears in the dataset as one of the active contributors, reflecting its growing role in the global discourse on technology-enhanced science education.
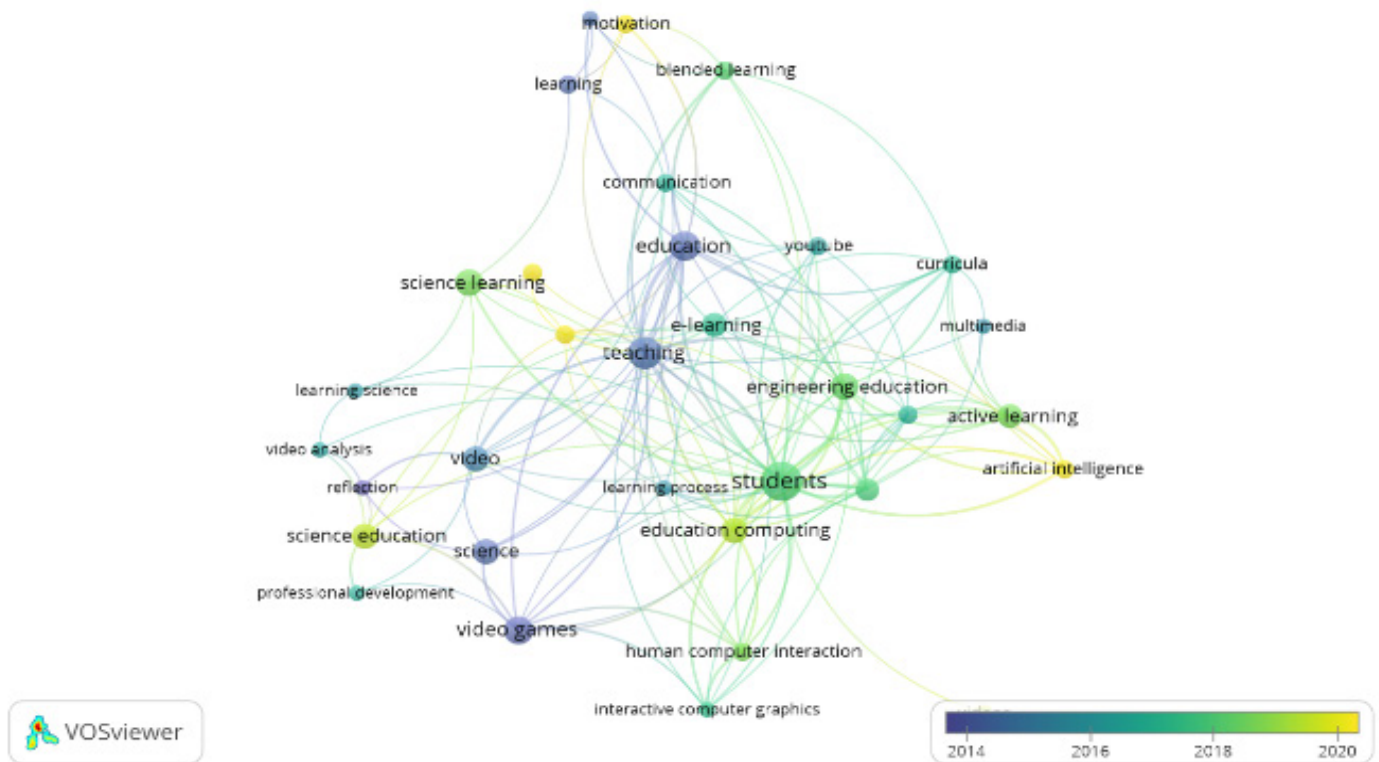
Author Keyword-Based Analysis

Figure 5. Keyword Network Visualization

The visualization of the author keyword network in figure 5 highlights the main themes in research related to the use of instructional videos in science education. Keywords such as "Teaching" and "Education" are at the center of the network, indicating that the primary goals of using videos are to enhance teaching effectiveness and learning experiences. Surrounding them, keywords like "e-learning," "blended learning," and "students" reflect the growing trends in digital and remote education. "Science education" and "science learning" reinforce the relevance of videos in explaining complex scientific concepts, while "artificial intelligence (AI)" and "video games" signal trends towards personalized learning and gamification to increase student engagement. Additionally, terms like "professional development" and "human-computer interaction" suggest that videos are also used for teacher professional training, integrating technology to enhance teaching quality. Overall, this analysis indicates that research on instructional videos not only focuses on teaching but also on technological innovation and educational personalization, which are crucial for 21st-century learning.

Author Collaboration-Based Analysis

Figure 8 shows clusters of closely collaborating authors, such as Goldman, R., and Pea, R., who are actively contributing to this research, as well as the cluster of Bender, D., and Lyon, C., who have smaller yet specific interactions. Meanwhile, authors like Marino, M.T., and Adiputra, D.K. appear more isolated, indicating research that may be more independent. The collaboration network analysis shows strong links among certain authors and institutions, indicating active knowledge exchange in the field of instructional videos in science education. Several clusters highlight cross-institutional and international collaborations, which reflect the interdisciplinary nature of the research. Prominent clusters include partnerships among scholars from North America and Europe, often centered on educational technology and science pedagogy. Other clusters involve contributions from Asian countries, particularly Indonesia and China, which demonstrate an increasing engagement of developing regions in global research networks. The structure of the network suggests that a small number of core authors play a central role in connecting different groups, thereby facilitating the transfer of ideas and methodologies

across institutions and regions. This pattern underlines both the concentration of expertise in leading centers and the emergence of new contributors that broaden the scope of collaboration in this field.

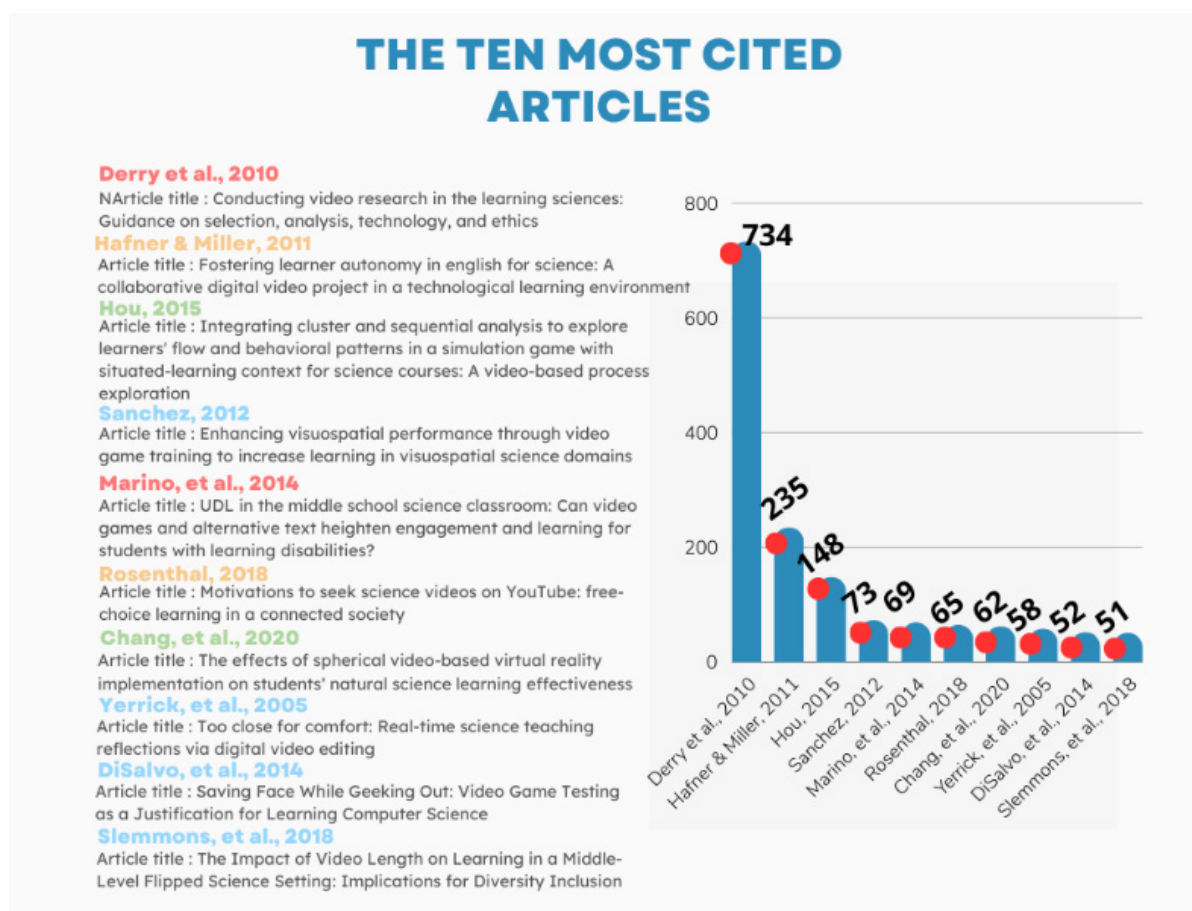**Figure 6**. Illustration of the Network of Author Collaborations

Figure 7. Top Ten Most Cited

Analysis Based on Country

The country distribution of publications on instructional videos in science education, as shown in figure 7, indicates that the United States has the highest output, reflecting its dominant role in educational technology

research. Indonesia ranks second, which demonstrates the increasing participation of developing countries in this field. Australia and China follow closely, adding evidence of the topic's relevance across both Western and Asian contexts. The presence of multiple regions among the leading contributors underscores the global character of research on instructional videos and confirms that interest in this area is not concentrated in a single geographic region. Instead, the distribution illustrates how diverse educational systems are engaging with technology-based innovations to address challenges in science learning.

Citation Impact Analysis

Highly cited publications represent influential contributions that shape the development of instructional video research in science education. Identifying these works provides insight into the foundational studies that have guided subsequent investigations. Citation analysis also reveals how earlier research has informed and inspired later studies, indicating both the impact and continuity of scholarly efforts in this field. Figure 7 presents the ten most cited articles included in this analysis.

DISCUSSION

The purpose of this study was to conduct a bibliometric analysis of research on instructional videos in science education. The findings confirmed a steady growth in publications, particularly after 2010, with contributions from both developed and developing countries. The United States emerged as the most productive country, while Indonesia ranked second, reflecting the expanding role of developing regions in educational technology research. This result indicates that instructional video research has become a global endeavor and is no longer concentrated solely in advanced economies.

Growth of Publications and Global Trends

The sharp rise in publications over the last decade aligns with the growing integration of digital technologies in education worldwide. Previous bibliometric studies on educational technology reported similar increases in topics such as learning management systems and online learning platforms.[73,74,75,76] However, unlike those studies that often highlighted Western dominance, our analysis shows that developing countries, particularly Indonesia and China, are actively contributing to the field. This supports claims by [77] That technological adoption in education is accelerating in Southeast Asia due to policy reforms and increased internet access.

Collaboration and Knowledge Exchange

Collaboration network analysis revealed strong links among authors such as Goldman et al.[4] consistent with earlier observations that certain scholars serve as intellectual hubs in educational video research. These findings reinforce the view that global collaboration is essential for advancing innovation in this area.[78,79] The emergence of Asian institutions, including Universitas Negeri Yogyakarta, illustrates how developing countries are becoming more integrated into international research networks, complementing the traditionally Western-centered collaborations.

Thematic Focus and Research Impact

The analysis of highly cited works illustrates several dominant themes in instructional video research.[4] The most cited article emphasized methodological rigor, data ethics, and the need for appropriate video analysis frameworks. Our findings confirm that these challenges remain central, as reflected in recurring keywords such as methodology, data analysis, and ethics. In contrast, more recent studies highlight the potential of AI, VR, and gamification in enriching video-based learning.[80,81,82,83,84,85,86,87,88,89] This thematic shift demonstrates how research has moved from methodological concerns to exploring technological affordances.

Another theme is student engagement and autonomy. Several cited works [90,91] Reported that structured video tasks and interactive environments foster higher levels of autonomy and motivation. These findings resonate with our bibliometric results, where engagement, student-centered learning, and autonomy appear as frequent keywords. Similarly, studies on video games and simulation-based environments[92,93] Provide empirical evidence that interactivity enhances reflective learning, a pattern visible in the clusters identified through keyword co-occurrence analysis.

Teacher Professional Development

Instructional videos are not only student learning tools but also resources for teacher education. Highly cited studies on preservice teachers[94,95] Demonstrate that digital video editing enhances reflection and pedagogical skills. This supports our observation that keywords such as teacher training and professional development frequently appear in the dataset. These results suggest that videos serve a dual purpose: improving science learning for students and strengthening the professional capacities of teachers.

Equity, Accessibility, and Future Directions

Despite global growth, our results also highlight gaps. Studies on Universal Design for Learning (UDL) and accessibility[96] Show that video-based approaches have potential for inclusive education, but outcomes vary across contexts. Likewise, research on YouTube usage in Singapore[97,98] reflects ongoing disparities in how students use videos for science learning. These findings align with our bibliometric observation that collaboration networks remain uneven, with limited representation from low-income countries. Addressing such inequities should be a priority for future research.

Looking forward, the convergence of instructional videos with emerging technologies such as AI, VR/AR, and gamification presents new opportunities. As noted by [89], students who engage with immersive video systems demonstrate stronger problem-solving and metacognitive skills. Our analysis of keyword trends also confirms a growing association between video research and terms such as artificial intelligence, virtual reality, and gamification. These insights indicate that the field is moving toward more personalized, interactive, and technology-integrated forms of science education.

Summary

Overall, this discussion highlights how bibliometric analysis complements earlier empirical studies by providing a broader picture of research development. The results reveal both the historical challenges (methodology, ethics) and the emerging opportunities (AI, VR/AR, gamification, inclusivity) that define instructional video research. By mapping global contributions and collaboration networks, this study contributes to a deeper understanding of how instructional videos have evolved into a transformative tool in science education, while also identifying areas that warrant future attention.

CONCLUSIONS

This study set out to provide a comprehensive bibliometric analysis of instructional video research in science education. The analysis confirms that the field has experienced steady growth over the past five decades, with increasing contributions from both developed and developing countries. The study also shows that research on instructional videos has evolved into a multidisciplinary and globally relevant area of inquiry.

The results highlight the central role of instructional videos as a transformative tool for enhancing science education, both in student learning and teacher development. They also emphasize the importance of collaboration across institutions and countries to sustain innovation and address methodological and ethical challenges.

More broadly, this study contributes to understanding how digital tools are reshaping educational practices and offers a global perspective on the trajectory of instructional video research. Future studies should continue to explore emerging technologies such as artificial intelligence, virtual and augmented reality, and gamification, while also addressing issues of equity, accessibility, and inclusivity in diverse educational contexts.

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CONFLICT OF INTEREST
The authors declare that there is no conflict of interest.

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