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Refutation Texts in the Last Decade: A Bibliometric Exploration of Trends and Insights

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ABSTRAK

Studi ini bertujuan untuk mengeksplorasi tren penelitian dan publikasi terkait teks sanggahan selama sepuluh tahun terakhir dengan menggunakan analisis bibliometrik. Data diperoleh dari basis data Scopus sebanyak 115 dokumen yang dipublikasikan pada tahun 2015–2024 dengan kata kunci "*refutation texts*", "*refutational texts*", atau "*rebuttal texts*". Data yang diperoleh menunjukkan fluktuasi jumlah publikasi, dengan puncak tertinggi terjadi pada tahun 2022. Penulis utama dalam bidang ini meliputi Kendeou, Sinatra, dan Danielson, dengan kontribusi terbesar berasal dari Amerika Serikat, diikuti oleh negara-negara Eropa seperti Jerman dan Kanada. Subjek penelitian yang dominan adalah ilmu sosial dan psikologi, dengan fokus pada penggunaan teks refutasi untuk menciptakan konflik kognitif dan mengubah konsepsi siswa. Analisis keterkaitan kata kunci menunjukkan hubungan erat antara teks sanggahan, miskonsepsi, dan perubahan konseptual. Temuan ini menyoroti pentingnya pendekatan berbasis teks sanggahan dalam mengatasi miskonsepsi siswa, serta membuka peluang untuk penelitian lebih lanjut terkait penerapannya dalam pembelajaran berbasis teknologi dan motivasi belajar siswa.

Kata kunci: Bibliometrik, perubahan konseptual, miskonsepsi, teks sanggahan, tren.

ABSTRACT

This study aims to explore research and publication trends related to refutation texts over the past ten years using bibliometric analysis. Data was obtained from the Scopus database of 115 documents published in 2015-2024 for "refutation texts" or "refutational texts" or "rebuttal texts". The data obtained showed fluctuations in the number of publications, with the highest peak occurring in 2022. The main authors in this field include Kendeou, Sinatra, and Danielson, with the largest contributions coming from the United States, followed by European countries such as Germany and Canada. The dominant research subjects are social sciences and psychology, with a focus on the use of refutation texts to create cognitive conflict and change students' conceptions. Keyword co-occurrence analysis shows a close relationship between refutation texts, misconceptions, and conceptual change. These findings highlight the importance of a refutation text-based approach in overcoming students' misconceptions, as well as opening up opportunities for further research on its application in technology-based learning and student motivation.

Keywords: Bibliometric, conceptual change, misconception, refutation texts, trends.

INTRODUCTION

Misconceptions often become obstacles in the learning process because students are not aware of errors in their understanding. This can affect students' ability to understand more complex concepts in the future (Kaniawati et al., 2020; Qian & Lehman, 2017; Suprapto, 2020). In this context, effective approaches to help students overcome misconceptions are urgently needed. One of the most effective ways to deal with misconceptions is to create cognitive conflict, which helps students realize contradictions in their own understanding (Menz et al., 2024; Ramsburg & Ohlsson, 2016; Vosniadou, 2020).

This cognitive conflict serves as a trigger for students to re-evaluate and correct errors in the knowledge they hold. Especially in situations where students need to change their basic knowledge in order to understand more complex concepts, as found in conceptual change (Nadelson et al., 2018; Ramsburg & Ohlsson, 2016; Samsudin et al., 2019). Refutation texts, which present discussions of misconceptions and immediately offer correct explanations, become an effective tool in creating the necessary cognitive conflict. Refutation texts include three major structures namely a description of popularly held misconceptions, a refutational statement suggesting that these notions are incorrect, and a presentation of the scientifically accepted concept as a counterexample (Fratiwi et al., 2020; Lem et al., 2017; Mason, 2018; Weingartner & Masnick, 2019).

Refutation texts have proven effective in helping students overcome misconceptions that can lead to errors in understanding and low performance in various fields of science (Ferrero et al., 2020; Harsch & Kendeou, 2023; Kowalski & Taylor, 2017; Will et al., 2019). The use of refutation texts allows students to check and correct incorrect understanding by providing more precise and valid explanations. Research also shows that students with limited knowledge, who are more prone to misconceptions, benefit significantly from refutation texts because these texts allow them to replace incorrect concepts with correct understanding (Asterhan & Resnick, 2020; Fratiwi et al., 2024; Prinz et al., 2022). Results from a meta-analysis spanning multiple disciplines show that refutation texts are effective in a variety of contexts, including mathematics, science, and social sciences, regardless of the type of test or time of test administration used (Schroeder & Kucera, 2022).

This research aims to analyze the development of research and publications related to refutation texts over the last ten years. According to Amiruddin et al. (2024), it is urgent to know the development of research topics because it can provide an overview of future research opportunities. The Scopus database is the primary source of information used in research because it is an internationally reputable indexer. Several questions must be answered in this study as follows:

1. What are the research and publication trends on refutation texts over the last 10 years?
2. Who are the most relevant authors and countries in the publication of articles about refutation texts during the last decade?
3. What are the main subject areas that have been covered in research on refutation texts?
4. What is the keyword co-occurrence pattern in refutation text?
5. What insights can be drawn for future research directions in the study of refutation texts?

METHODS

This research uses bibliometric analysis to explore research and publication trends on refutation texts over the last ten years. Bibliometric analysis is a combination of qualitative and quantitative approaches that provide in-depth insight into the topics discussed, allowing researchers to obtain the latest and most relevant information (Ding et al., 2022; Donthu et al., 2021; Zupic & Čater, 2015). In this context, refutation texts were chosen as a research topic because of their significant role in supporting changes in conceptions and overcoming misconceptions in learning.

The first step in this analysis was a search for relevant articles with the keywords “refutation texts” or “refutation texts” or “rebuttal texts” in the Scopus database, which includes publications from 2015 to 2024. The focus of this search was limited to English language documents to ensure uniformity in understanding and representation of data. The data obtained is saved in CSV and RIS format, and then analyzed using VosViewer and Ms-Excel software, which were chosen for their ability to visualize research trends, researcher collaboration, and relationships between articles and topics. The workflow for this research is as Figure 1.

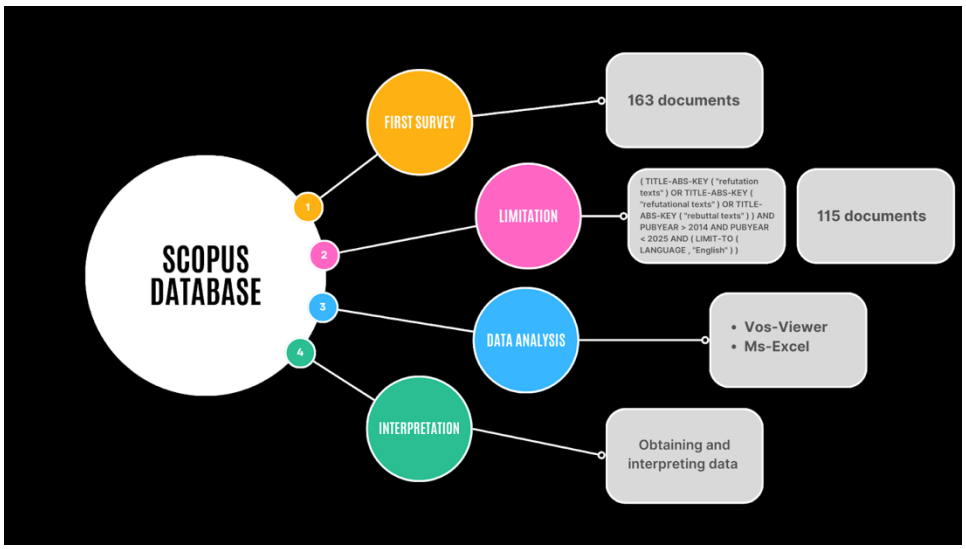

Figure 1. Research flowchart

RESULTS

Research and publication trends on refutation texts over the last 10 years

Based on bibliometric analysis from the Scopus database, publications regarding refutation texts show a fluctuating increasing trend during the period 2015 to 2024 as shown in Figure 2.

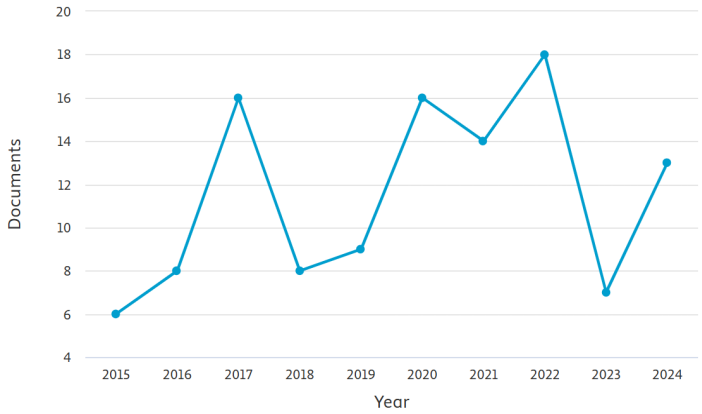

Figure 2. Annual Scientific Production on Refutation Texts

Overall, there were 115 documents identified in that period. The number of publications fluctuated, with a consistent trend of increasing from 2018 to 2022. However, there was a decrease in the number of publications in certain years, namely between 2017 and 2018, as well as from 2022 to 2023. The highest peak in the number of publications occurred in 2022, with the total 18 documents published, which is the highest figure in the last decade. A consistent upward trend was seen in the period 2018 to 2022, indicating a growing interest in refutation texts in educational research.

Dominant authors and countries in refutational text research

Based on bibliometric analysis, the authors who contributed most to the publication of articles on refutation texts during the last decade came from various countries with significant contributions, as shown in Figure 3. The main authors in this field include Kendeou, P. (16 documents), Sinatra, G.M. (10 documents), and Danielson, R.W. (9 documents), which has studied the application of refutation texts in various learning contexts and their influence on changes in students' conceptions. Kendeou is known for his research discussing the use of refutation texts to overcome misconceptions, while Sinatra, Danielson, and other authors focus on the influence of refutation texts on students' understanding in the context of science and mathematics education.

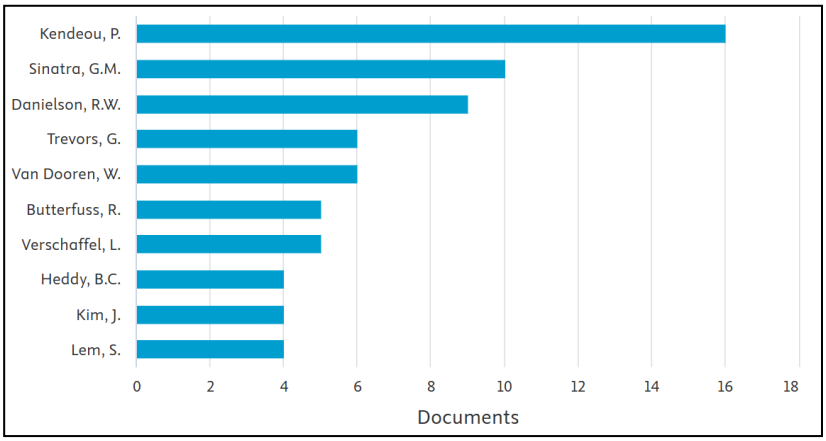

Figure 3. Authors' Production on Refutation Texts

In terms of country, the predominance of authors comes from the United States, Germany, Canada, Australia and other European countries, with significant contributions in the fields of education and cognitive psychology, as shown in Figure 4. The United States recorded the highest number of publications, with more than half of the articles analyzed coming from authors affiliated with the country's universities, followed by Germany and Canada which also have significant contributions to refutation text research. European countries such as Belgium, Finland and Sweden also actively participated in this publication.

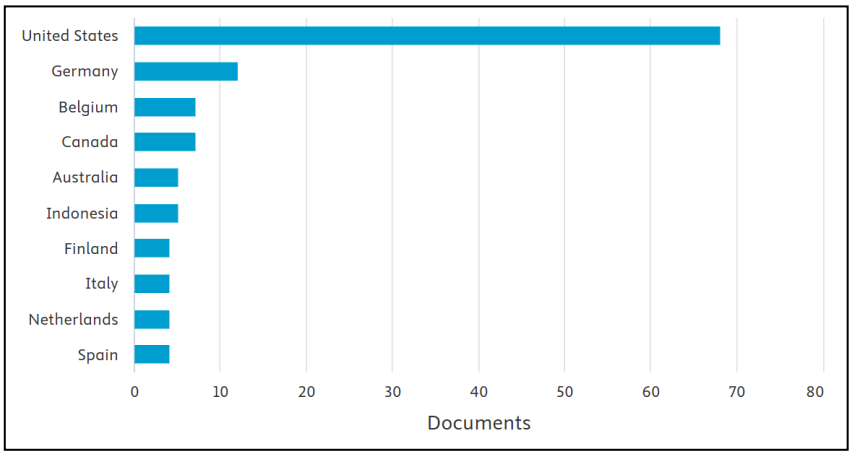

Figure 4. Countries Production on Refutation Texts

International collaboration is highly visible in these publications, with many researchers working together on multinational research projects. This collaboration shows the importance of global contributions in enriching the literature on refutation texts, and researchers from Indonesia are also starting to play a role in international collaborations even though the number of their publications

is still smaller than in developed countries. The increased involvement of developing countries such as Indonesia shows positive developments in global contributions to this field.

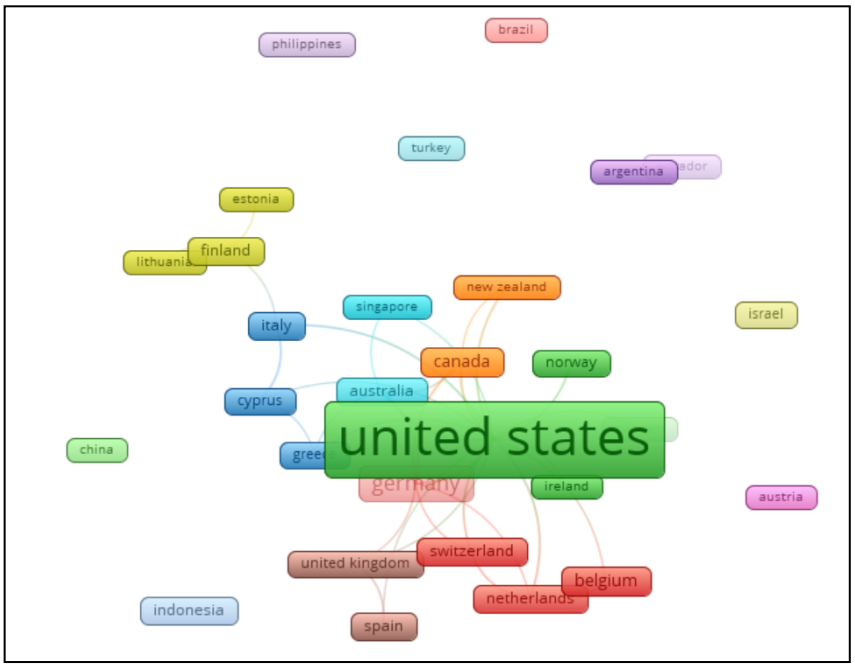

Figure 5. Collaboration among Researchers on Refutation Texts in the World

Key Subject Areas in Refutation Text Research

Based on bibliometric analysis, the main subjects that are the focus of research on refutation texts can be categorized into several scientific fields. The data in Figure 6 shows that the majority of research on refutation texts is in the realm of social sciences, with a contribution of 39.2%. In second place, the field of psychology accounted for 27% of the total research analyzed. Apart from that, a significant contribution was also seen from computer science (7.7%). Meanwhile, the humanities field accounted for 6.8% of research. Some other subjects that received attention were mathematics (4.1%) and physics and astronomy (2.7%). The fields of medicine (2.3%) and neuroscience (2.3%) also contributed. More specific but still relevant research is seen in the fields of biochemistry, genetics, molecular biology (1.4%) and earth sciences (1.4%). Meanwhile, the miscellaneous category covers 5.4% of the total research.

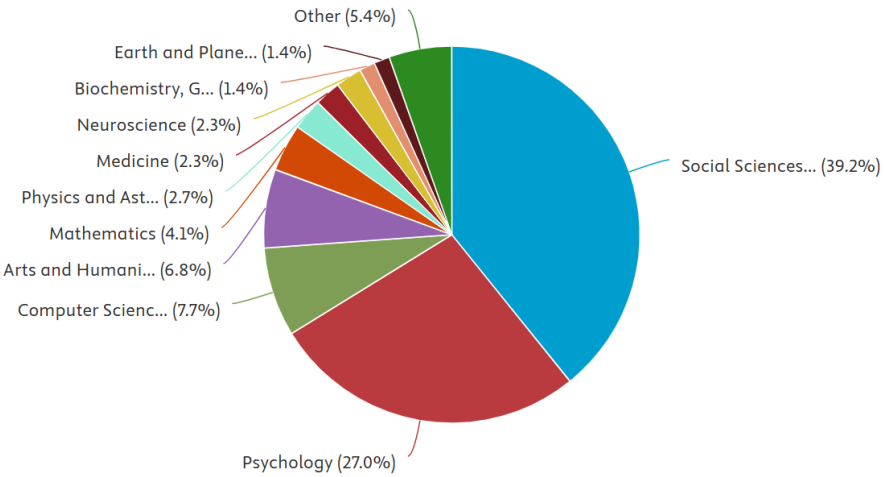

Figure 6. Subject Area of Research on Refutation Texts

Keyword Co-Occurrence Patterns in Refutation Texts

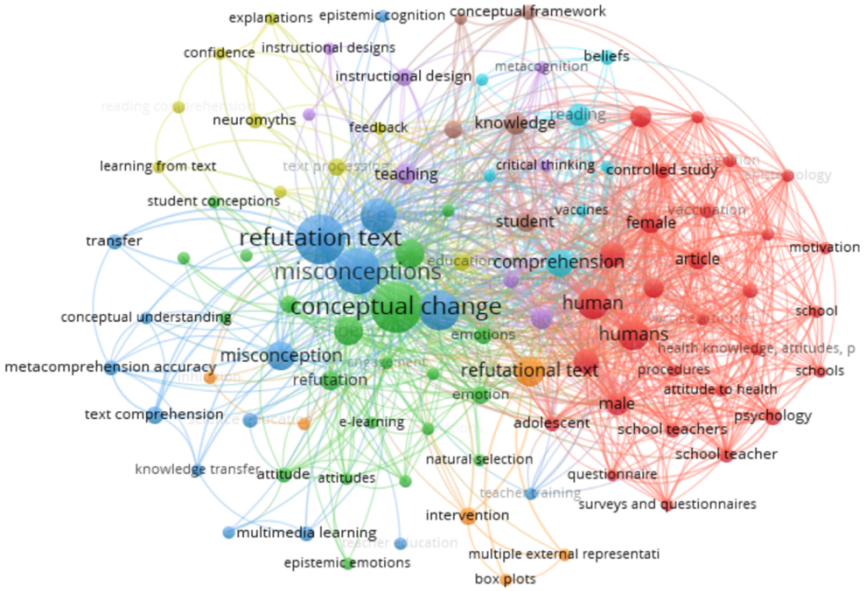

Figure 7. Keywords Co-occurrence Patterns

Based on the visualization of the keyword co-occurrence network, analysis of research patterns in refutation texts shows the existence of key themes which are the main focus in the literature studied. The three biggest keywords that appeared in the network, namely “refutation text”, “misconceptions”, and “conceptual change”, indicate that research on refutation texts is very focused on the ability of these texts to overcome misconceptions and encourage conceptual change in students’ understanding.

The visualization also depicts the relationship between these keywords through connecting lines, which show the co-occurrence of these words in many pieces of literature. Groups of terms that appear repeatedly are grouped with the same color, indicating a grouping of closely related concepts. Further analysis shows two dominant clusters, namely the blue and green clusters. The blue cluster, which is the largest cluster, consists of 16 terms such as “conceptual understanding”, “misconception”, “refutation texts”, “science education”, “teacher education”, “knowledge revision”, and “epistemic cognition”. Meanwhile, the green cluster consists of 21 terms, such as “conceptual change”, “student conceptions”, “students’ misconceptions”, “students”, “learning”, “e-learning”, and “attitude”. Interestingly, the red cluster shows a stronger relationship with human attributes, such as “motivation” and “psychology”.

Insights for Future Research on Refutation Texts

Based on an analysis of the keyword co-occurrence network visualization showing the development of literature related to refutation texts from 2015 to 2024, interesting trends were found that illustrate a shift in research focus and the emergence of new, relevant topics. The colors from purple to yellow in this visualization indicate the evolution of research over the years, with items colored greenish yellow indicating the most recent findings to appear in the literature, namely “education computing.” This item shows that the application of technology in education, especially in the context of refutation texts, is increasingly becoming a major concern in current research.

The greenish-yellow “education computing” is closely related to several other new items, such as “attitudes”, “refutation”, “engagement”, and “emotions”. This reflects that research on refutational texts is now not only limited to conceptual learning and overcoming misconceptions, but

is also starting to include students' psychological and motivational aspects, as well as the application of technology to increase interaction and involvement in the learning process. Research on "attitudes" also shows that there is increasing attention to students' attitudes towards learning, particularly how their attitudes influence the successful use of refutational texts.

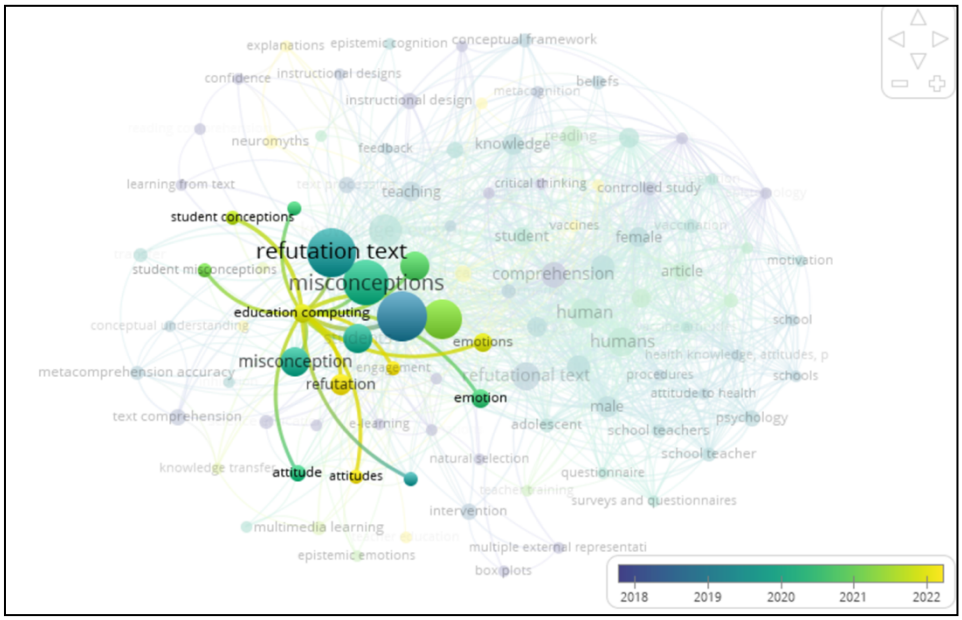

Figure 8. Overlay Visualization of the Co-Word Analysis Results

DISCUSSION

Research and publication trends on refutation texts over the last 10 years

The results indicate a growing interest in refutation texts, particularly between 2018 and 2022, as reflected by the steady increase in publications during that period. The peak in 2022 suggests heightened scholarly attention toward addressing misconceptions through this instructional approach. This is in line with previous findings that refutation texts are considered an effective method for overcoming misconceptions among students in various fields of study, such as mathematics, science, and physics (Danielson et al., 2016; Ferrero et al., 2020; Mason, 2018; Weingartner & Masnick, 2019; Zengilowski et al., 2021).

However, the decline in publications in 2022-2023 could be influenced by external factors, such as the COVID-19 pandemic, which affects research priorities or research funding (Damaševičius & Zailskaitė-Jakštė, 2023; He et al., 2023). This temporary decline may also be related to changes in academic publication patterns or research focus shifting to other areas, such as online learning becoming more dominant during the pandemic.

Dominant authors and countries in refutational text research

The dominance of authors such as Kendeou, Sinatra, and Danielson highlights the central role they play in advancing research on refutation texts, particularly in exploring their application in educational contexts to address students' misconceptions. Their consistent contributions over the last decade reflect the growing recognition of refutation texts as a valuable pedagogical tool in fields like science and mathematics education.

The bibliometric findings also reveal a geographical concentration of productivity, with the United States leading significantly in publication output, followed by Germany, Canada, and several European countries. This suggests that research on refutation texts has been predominantly driven by institutions in developed countries, likely due to stronger academic infrastructure and research funding in education and cognitive psychology.

Moreover, the presence of international collaboration across studies underlines the global relevance of this topic. The participation of researchers from various countries, including emerging contributions from Indonesia, indicates an encouraging trend toward more inclusive and diverse perspectives in the development of refutation text research. This global engagement not only enhances the quality of scientific discourse but also expands the potential for contextual applications across different educational systems.

Key Subject Areas in Refutation Text Research

Research in social sciences, particularly in education, emphasizes the use of refutation texts to address student misconceptions through cognitive conflict-based learning. This dominance underlines the importance of social and pedagogical approaches in utilizing refutational texts as learning tools. Psychology, as the second most dominant field, explores how cognitive mechanisms facilitate conceptual change, supporting the theoretical basis for using refutation texts in learning.

The growing contribution from computer science reflects a shift toward integrating technology in educational interventions, such as AI-driven systems that utilize refutation texts for personalized learning. Contributions from fields like humanities, mathematics, physics, and health sciences show the adaptability of refutation texts across diverse domains, including communication, complex scientific reasoning, and biomedical understanding. Although contributions from some disciplines remain relatively small, their presence indicates the broad applicability and potential of refutation texts in promoting deeper conceptual understanding across a wide range of subjects.

Keyword Co-Occurrence Patterns in Refutation Texts

The prominence of keywords like “refutation text”, “misconceptions”, and “conceptual change” reflects the central role of refutation texts in addressing erroneous understandings and facilitating students' conceptual change. These findings are supported by Jin et al. (2024), who highlight the effectiveness of refutation texts in correcting long-standing misconceptions in science education contexts. The network visualization emphasizes how refutation texts are interconnected with educational constructs and the design of effective instructional materials. Mason (2018) emphasized that refutation texts must actively refute incorrect beliefs rather than merely present correct information, pointing to the need for dynamic and interactive learning resources.

The blue cluster reinforces the significance of refutation texts in science education and teacher training. The appearance of terms like “teacher education” and “epistemic cognition” suggests that educators must be equipped not only with content knowledge but also with pedagogical strategies to implement refutation texts effectively. This aligns with Ferrero et al. (2020), who argue for teacher preparation in using refutational tools to support students’ knowledge revision.

The green cluster reveals the broader implications of refutation texts in shaping student attitudes and behaviors, especially when integrated into digital learning platforms. The association with “e-learning” indicates the growing potential of technology to enhance the accessibility and engagement of refutation texts. Rajendra & Sudana (2018) support this by demonstrating how multimedia tools can improve students’ conceptual understanding.

Finally, the red cluster’s focus on “motivation” and “psychology” highlights the importance of affective factors in the learning process. Students’ acceptance of refutation texts is influenced not just by content but also by their confidence, willingness to change, and perception of the material. This is consistent with Mazana et al. (2018), who found that students’ attitudes significantly affect their responsiveness to conceptual change. Therefore, designing effective refutation texts requires attention to cognitive, motivational, and emotional aspects.

Insights for Future Research on Refutation Texts

The emergence of terms such as “education computing”, “engagement”, and “emotions” in recent years illustrates a shift in the focus of research on refutation texts. No longer confined solely to the cognitive domain of correcting misconceptions, this body of research is expanding to explore affective and motivational factors that influence how students engage with and accept refutational content. The inclusion of terms like “attitudes” and “emotions” suggests that learners’ feelings,

motivation, and psychological readiness are being recognized as important elements in facilitating conceptual change.

This evolution is particularly significant in the context of digital learning environments. As educational computing gains prominence, researchers are beginning to investigate how technology, through e-learning platforms, interactive content, or multimedia, can enhance the effectiveness of refutation texts by making them more engaging and responsive to students' emotional states. The association of refutation with "engagement" and "emotions" highlights the pedagogical need for emotionally intelligent learning designs that not only correct misconceptions but also foster active involvement and positive learning attitudes.

Furthermore, this integrative trend aligns with broader developments in educational research that emphasize the role of emotion, motivation, and social interaction in learning. The use of refutational texts is thus being reframed, not just as a method for conceptual restructuring but as a holistic educational tool that incorporates technological affordances and affective supports. Future research might focus on how to leverage technology to address emotional barriers, increase student engagement, and facilitate more effective conceptual change through tailored, student-centered refutational experiences.

CONCLUSION

This research provides insight into the research and publication trends of refutation texts over the last ten years. Bibliometric analysis shows that although there are fluctuations in the number of publications, there is a significant increase between 2018 and 2022, with the highest peak in 2022. The main researchers come from countries such as the United States, Germany, and Canada, with a dominant research focus in the field of science social issues, especially in education and psychology. These findings highlight the important role of refutation texts in overcoming student misconceptions and encouraging conceptual change, as well as their potential application in technology-based learning.

Based on these findings, further research can focus on developing refutational texts in technology-based learning contexts, such as e-learning, to increase accessibility and interactivity. In addition, it is important to deepen studies regarding the application of refutation texts in various disciplines, such as mathematics and physics, and their influence on the development of teachers' epistemic awareness. Special training for educators in the use of refutative texts also needs to be prioritized so that this strategy can be implemented more effectively in teaching at various levels of education.

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