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Integrative Learning Models For Numeracy Literacy And Character Development: Insights From A Bibliometric Analysis

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ABSTRACT

Objective: This research aims to map global trends in integrative learning models that combine numeracy literacy and character development, to provide in-depth insight into the contributions of existing research and the gaps that need to be addressed. **Method:** The method used is quantitative-based bibliometric analysis, with data collected from the Scopus database in the time period 2002–2024. Analysis was carried out using VOSviewer and R-Studio software to identify publication patterns, collaboration networks between authors and institutions, and dominant research themes. **Results:** The research results show a significant increase in related publications since 2016, with a peak in research activity in 2024. The main findings indicate that the topics of numeracy literacy and character development are increasingly gaining global attention, with the largest contributions coming from the fields of social sciences, computer science, and education. Co-occurrence analysis reveals that terms such as "e-learning," "digital literacy," and "project-based learning" are the main focus in the integration of numeracy literacy and character development. **Novelty**: The implication of this research is the need to develop evidence-based integrative learning models that can be adapted contextually to improve student learning outcomes holistically.

INTRODUCTION

The development of 21st century education emphasizes the importance of integrative learning to build student competencies holistically. Modern education does not only focus on cognitive aspects, but also aims to develop numeracy literacy as a basic ability in solving mathematical problems, as well as character as a foundation for ethics and morals. The combination of these two elements is believed to be able to create individuals who are competent, creative and have integrity in facing global challenges.

David (2024) emphasizes the importance of a holistic approach that integrates 21st century skills, such as critical thinking, communication, and collaboration, to prepare students for an interconnected world. Additionally, Singh et al. (2024) highlights the important role of education in building global literacy and sustainability through a curriculum that is inclusive and relevant to today's needs. Howard et al. (2019) also added that educational transformation requires visionary leadership to create schools that support continuous learning and sustainable community development.

Furthermore, Lavy (2020) shows that the development of character strengths, such as integrity and responsibility, is an important basis in 21st century education, especially in connecting it with intrapersonal and interpersonal competencies. In the context of numeracy literacy, González-Pérez and Ramírez-Montoya (2022) identified that the integration of technology and active learning strategies can significantly improve students' numeracy skills. By combining an integrative approach and character development, 21st century education can produce individuals who are not only

academically competent, but also have global awareness and the ability to adapt to dynamic change.

However, efforts to integrate numeracy literacy and character development in learning models still face various challenges. One of the main challenges is the lack of learning models that are scientifically tested and applied consistently in various educational contexts. Although much research has been conducted separately on numeracy literacy and character development, integrative approaches that combine the two are still limited, both in terms of theory and practice. As a result, there is a gap in understanding regarding how integrative learning models can be implemented effectively to improve student learning outcomes.

The empirical results of Gunawan et al. (2023) developed the RADEC learning model that integrates literacy and numeracy through teacher professional development training, which shows an increase in teachers' ability to design literacy and numeracy-based learning effectively. In addition, Ginanjar et al. (2024) successfully implemented an integrative learning model based on Islamic values from the Al-Qur'an and Hadith which showed its effectiveness in improving student character. Tyaningsih et al. (2023) also highlights the effectiveness of the Project-Based Learning model in improving students' numeracy literacy skills through lesson study practices in schools.

Furthermore, Aini et al. (2024) shows that the application of STEAM learning based on local wisdom can significantly improve students' literacy and numeracy skills. Sulthon (2024) emphasizes the importance of the thematic integrative learning model in shaping student character through an approach that is connected to relevant themes. Thus, an approach that combines numeracy literacy and character development requires a model that is scientifically tested and adapted to the local context to produce optimal learning outcomes.

The research results of Pishtari et al. (2023) conducted a bibliometric-based systematic review of analytics-based learning models that shows how partnerships between teachers and intelligent systems can improve the learning process. Apart from that, Supriyadi et al. (2024) analyzed articles in Scopus about phenomenon-based learning, showing its important contribution in improving students' thinking skills at various levels of education. In the context of project-based learning, Konu Kadirhanogullari and Ozay Kose (2023) use bibliometric analysis to reveal relevant research trends and content, especially in science education.

Furthermore, Yuliyanto et al. (2023) provide a comprehensive overview of the Technological Pedagogical Content Knowledge (TPACK) model through bibliometric analysis, which shows the importance of technology integration in the learning process. Demir (2023) highlights the application of machine learning in teacher education research, providing insight into how technology can improve the effectiveness of teacher training. With this approach, research on integrative learning models can continue to develop and make a significant contribution to improving the quality of values and numeracy-based education at the global level.

Therefore, this research aims to map research trends in integrative learning models that focus on numeracy literacy and character development. It is hoped that the findings from this analysis can make an important contribution to the preparation of educational policies, curriculum design, and the development of pedagogy that is more holistic and in line with the needs of the times.

RESEARCH METHOD

This research uses a quantitative approach based on bibliometric analysis to explore global trends, patterns and contributions in research on integrative learning models for numeracy, literacy and character strengthening. This method is designed to understand historical developments, prominent authors, and emerging research areas. Data was obtained from several main sources, namely Scopus for wider coverage from journals of international reputation. The time span analyzed covers 2002-2024 to capture historical developments and current trends.

The data collection technique begins with an initial search using predetermined keywords in the database, followed by downloading article metadata, including title, author, year, institution, country, keywords, abstract, journal and references. Data selection was carried out based on inclusion criteria, namely articles that specifically discussed numeracy, literacy, integrative learning models, and character strengthening. Articles that were not relevant or only briefly mentioned the topic were excluded from the analysis.

Data analysis was carried out using bibliometric analysis techniques, which include temporal distribution to identify the number of annual publications and geographic distribution to determine the dominant countries and institutions in related research. Author and collaboration analysis was carried out to identify authors with significant contributions and analyze collaboration between authors and institutions using VOSviewer and R Studio.

This research approach uses the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework aimed at identifying, filtering and analyzing literature systematically to obtain articles that are relevant to the research topic. Based on the PRISMA diagram displayed, the steps followed include four main stages: identification, screening, eligibility assessment, and inclusion.

At the identification stage, a literature search was carried out in the Scopus database using keywords such as Learning Model, Character, Numeracy, and Literacy. From this search, 637 documents were obtained. The next stage is filtering, where documents that do not meet the criteria are excluded, such as non-journal articles, duplicates, or those that are not relevant to the research topic. At this stage, only 38 documents have passed for further examination.

Next, at the feasibility assessment stage, an evaluation was carried out on 599 documents that met the inclusion criteria such as publication year range (2002–2024) and relevant topics. Documents that included bibliometrics, systematic articles, or meta-analyses (287 articles) were excluded from the analysis. Finally, at the inclusion stage, 312 articles were selected for further analysis in the research.

This PRISMA approach provides transparency and systematic structure in literature selection thereby ensuring the validity and relevance of research findings. This method is often referred to in systematic review studies, one of which is described in Moher et al. (2009), who introduced PRISMA as a standard guideline for reporting systematic reviews and meta-analyses (Prisma, 2009). The Prisma approach can be explained in figure-1 below:

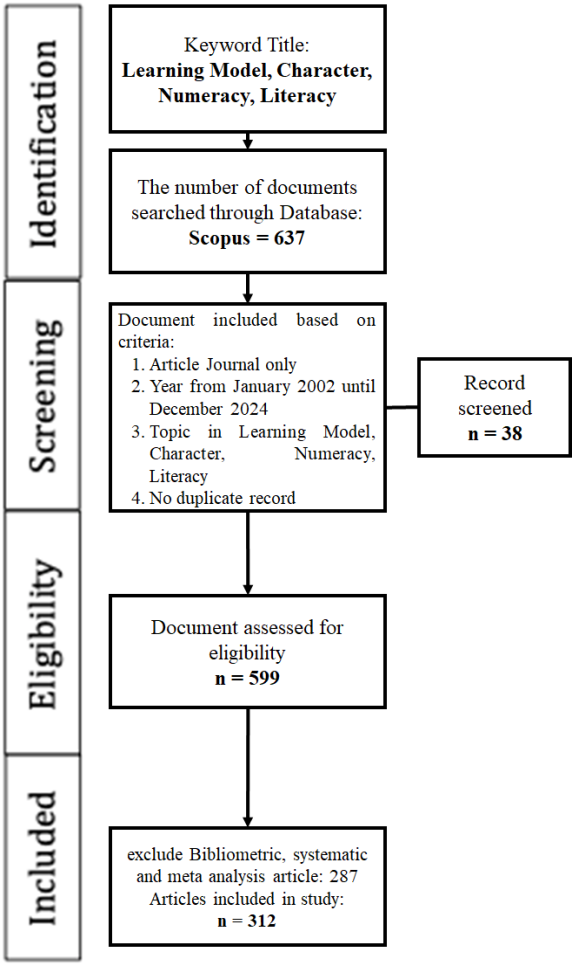

Figure 1. Prisma

RESULTS AND DISCUSSION

Results

1. Documents by Year

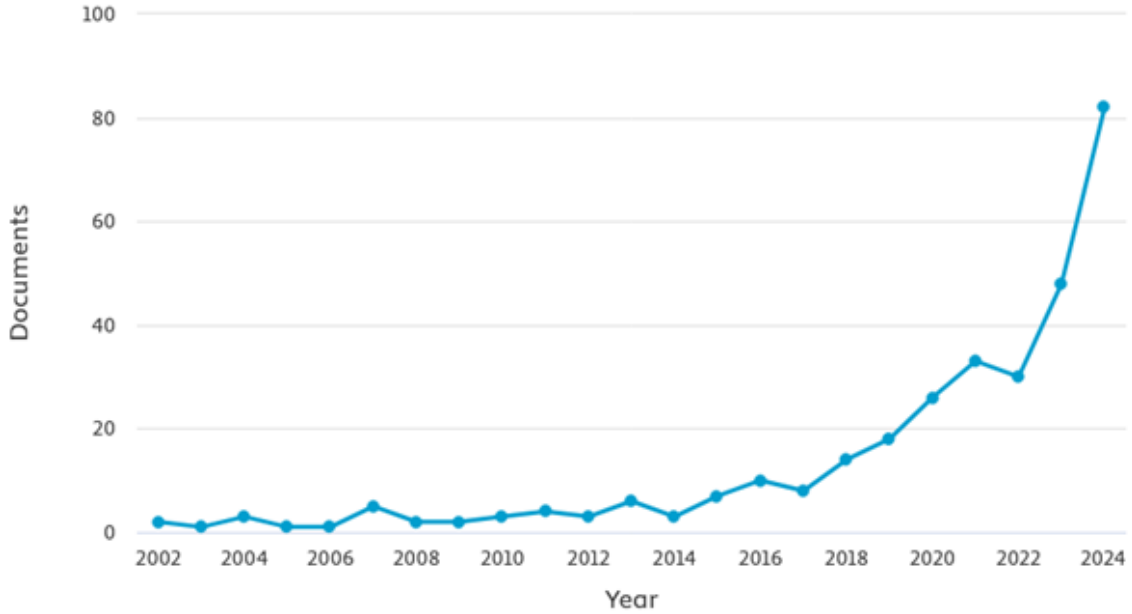

Figure 2. Documents by Year

The graph shows the number of documents published each year based on search results in the Scopus database from 2002 to 2024 on certain topics, namely Learning Models, Character, Numeracy and Literacy. The following is a more detailed explanation of the pattern displayed:

a. 2002–2010 period: The number of documents published each year is relatively low and stable, with an average of less than 5 publications per year. This shows that this topic has not been the main concern of researchers in this period.

b. 2011–2020 period: The number of documents begins to increase slowly, indicating an increase in researchers' interest in the topic. It can be seen that around 2016 and above, the graph shows a more significant upward trend, although still in moderate amounts

c. 2021–2024 period: A very significant spike in the number of documents occurred, especially in 2023 and 2024. This sharp increase reflects high academic attention to the topics of Learning Models, Character, Numeracy, and Literacy, which may be driven by education policy, the need for literacy and numeracy in the digital era, or a response to global developments in learning.

d. Peak in 2024: 2024 recorded the highest number of documents in the entire period under review, with more than 80 documents. This indicates a very active increase in research activity and the relevance of this topic in recent times.

In conclusion, this graph depicts the evolution of research attention to related topics over time, with a significant increase in recent years. This phenomenon can be attributed to increasing awareness of the importance of effective learning approaches and the integration of character, literacy and numeracy in the global education system.

2. Documents by Subject Area

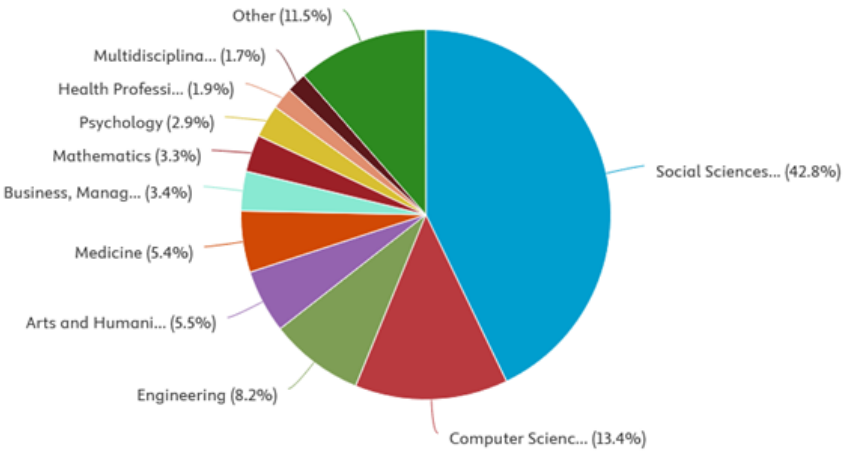

Figure 3. Documents by Subject Area

The figure shows the distribution of documents by subject area resulting from a search in the Scopus database. The majority of research, namely 42.8%, comes from the field of social sciences, indicating a primary focus on aspects of learning, literacy and numeracy in social, cultural and educational contexts. The field of computer science accounted for 13.4% of documents, which are likely related to the development of learning technologies such as e-learning and educational information systems. Engineering contributed 8.2%, reflecting the role of technology in supporting the design of learning tools and the integration of numeracy in engineering education. Arts and

humanities accounted for 5.5%, with a focus on character values in education, while medicine (5.4%) and health professions (1.9%) showed relevance in health education and numeracy literacy training in the health sector.

Furthermore, the fields of business, management and accounting (3.4%) contributed to research related to numeracy and literacy learning in the context of human resource development. Mathematics (3.3%) provides a focus on teaching numeracy, while psychology (2.9%) plays a role in examining learning behavior, motivation and individual development. A total of 1.7% of documents come from multidisciplinary research that combines various perspectives. The remainder, namely 11.5%, came from other categories, reflecting the wide application of Learning Model, Character, Numeracy and Literacy topics in various scientific disciplines. This distribution shows the interdisciplinary nature of the topic as well as the importance of integrating a holistic learning approach to support education and community development.

3. Main Information

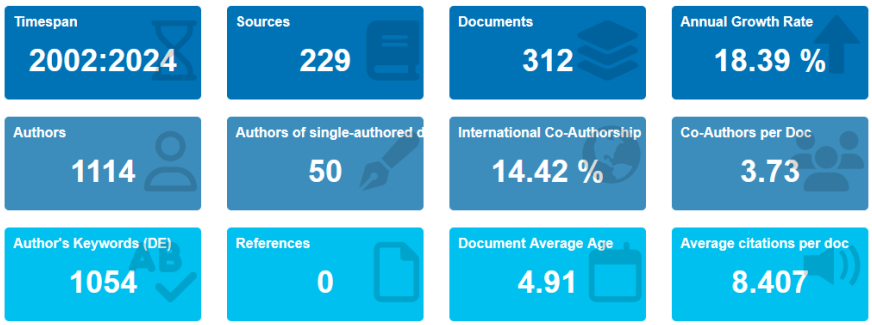

Figure 4. Main Information

The figure presents a bibliometric analysis of related publications in the time span from 2002 to 2024. Overall, there are 312 documents published in 229 different sources, with an average annual growth rate of 18.39%. The study involved 1,114 authors, with only 50 documents written by a single author, indicating a high level of collaboration. Each document has an average of 3.73 authors, and approximately 14.42% of the total documents involve international collaboration, indicating the global relevance of the topics discussed. Additionally, the analysis noted 1,054 keywords used to describe various aspects of the research, while the average age of the documents was 4.91 years, indicating that most of the research was new and relevant. On average, each document received 8,407 citations, indicating significant academic impact. Overall, this analysis reflects the rapid growth, widespread attention, and important contributions to the development of knowledge in the topics analyzed.

4. Thematic Map

The image is a Thematic Map which groups research themes based on level of development (density) and relevance (centrality). Themes in the Motor Themes quadrant (top right), such as "human," "article," and "humans," have a high level of development and relevance, indicating that these themes are mature and becoming the main focus of research. The Basic Themes quadrant (bottom right), which includes "teaching," "e-learning," and "information literacy," represents themes that are relevant as a basis for further research, although the level of development is still low. On the other hand, the Niche Themes quadrant (top left), such as “cross-sectional studies” and “health personnel attitudes,” shows themes with a high level of development but lower relevance, which generally focus on specific areas. Meanwhile, the Emerging or Declining Themes quadrant (bottom left), such as "students," "learning systems," and

"education computing," depicts themes that have low relevance and level of development, which may be in decline or just starting to develop. This map provides a comprehensive overview of the focus and potential for research development, as well as identifying dominant and underdeveloped areas.

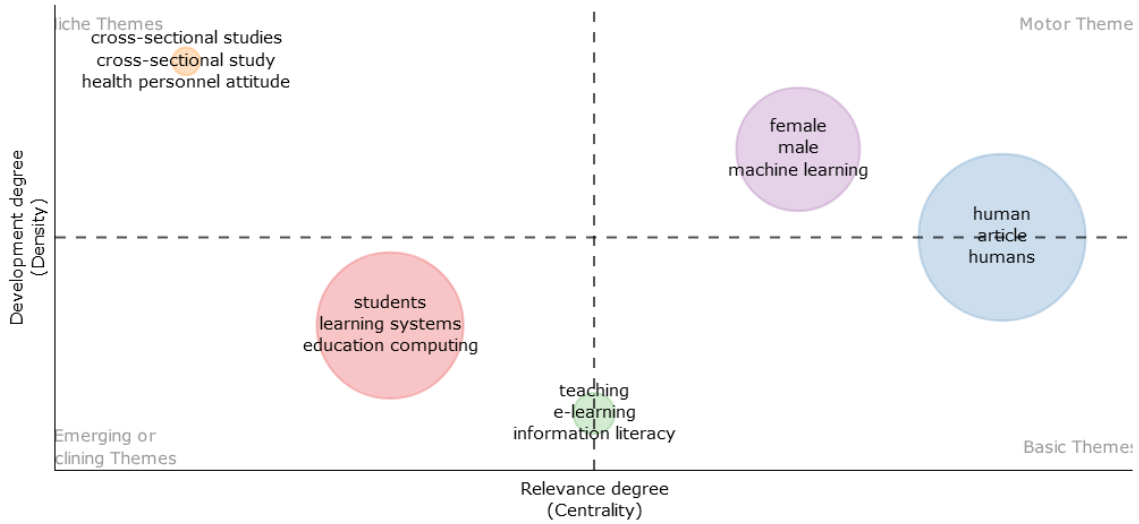

Figure 5. Thematic Map

5. Co-Occurrence Network

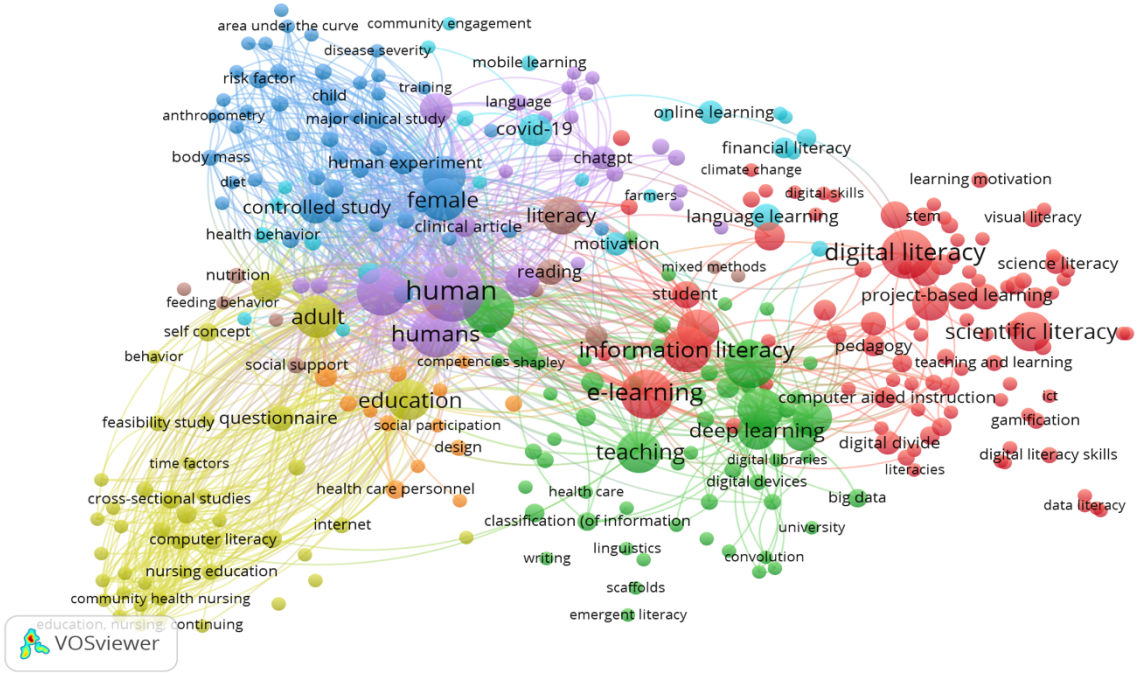

Figure 6. Co-Occurrence Network

This image is the result of co-occurrence network analysis from VOSviewer which illustrates the relationship between keywords or terms that often appear together in publications. Each circle (node) represents a term, where the size of the node reflects the frequency with which the term appears; the larger the node, the more often the term is used. The connecting lines (edges) between nodes indicate the relationship or co-occurrence between two terms, with the thickness of the line reflecting the strength of the relationship. Different colors indicate main theme groups (clusters), which depict terms that are closely related to each other.

The green cluster includes terms such as “e-learning,” “teaching,” and “information literacy,” which focuses on information literacy and technology in education. The red cluster contains terms such as "digital literacy," "scientific literacy," and "project-based learning," which emphasize digital literacy and modern learning approaches. The blue cluster relates to health research, including terms such as “female,” “clinical article,” and “controlled study.” Meanwhile, the yellow cluster includes terms such as "education," "social participation," and "health care personnel," which relate to education and health services.

This network shows the linkages between clusters, reflecting relationships between themes such as the integration of digital literacy in education or its link to health services. Overall, this visualization provides insight into key themes in the research, pinpoints the most relevant terms, and identifies connections between topics within the analyzed field.

6. Heat Map

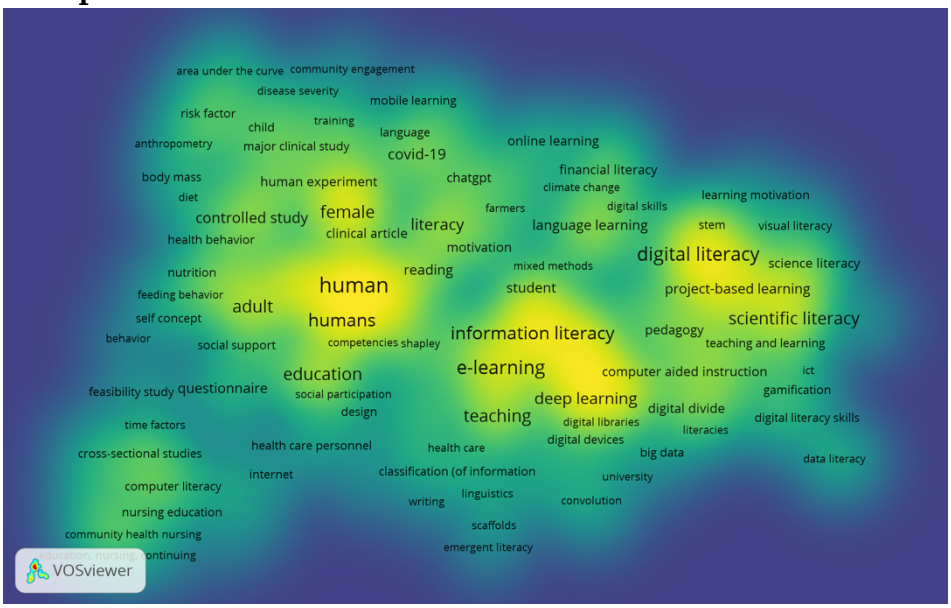

Figure 7. Heat Map

The image is a heatmap resulting from analysis using VOSviewer which depicts the distribution and intensity of the frequency of occurrence of keywords in the research network. The colors on the heatmap indicate the level of frequency or priority of a keyword, where yellow indicates the highest frequency, while green and blue indicate lower frequencies.

Keywords such as “human,” “humans,” “information literacy,” and “e-learning” are centered in bright yellow, reflecting that these terms have a very high frequency of occurrence and are the main focus in the research analyzed. Other keywords such as “digital literacy,” “scientific literacy,” and “teaching” also stand out in yellow-green, indicating that these themes also have an important role in the research network.

Meanwhile, terms such as "controlled study," "education," "computer literacy," and "cross-sectional studies" are in the green area, showing a significant frequency of occurrence but lower than the core terms. Terms in the blue area, such as “community health nursing,” “feasibility study,” or “gamification,” show lower frequency, and so may be less dominant or focused topics in certain contexts.

Overall, this heatmap provides a visual overview of the dominant themes in the research, showing the main focus as well as the distribution of other supporting themes

in the context of the research network. It can be used to identify key, well-established topics and under-explored research areas.

7. Collaboration Network Between Writers

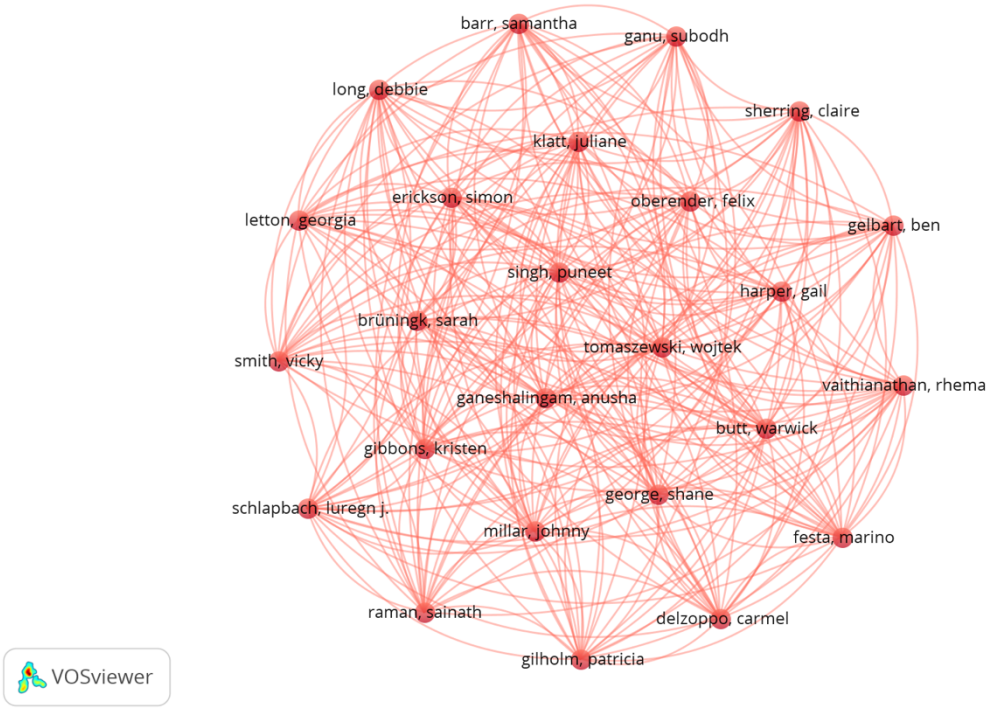

Figure 10. Collaboration Network Between Authors

The image is a visualization of the collaboration network between authors based on analysis using VOSviewer. Each node in the figure represents an author, while the lines connecting the nodes indicate the collaboration relationship between them, i.e. the extent to which two or more authors collaborate on a scientific publication. The size of the nodes reflects the number of publications or contributions of that author in the network, while the thickness of the connecting lines reflects the strength of the collaboration, which is calculated based on the number of joint publications.

From this visualization, it can be seen that authors such as Klatt Juliane, Erickson Simon, and Singh Puneet have significant connections with many other authors, reflecting their role as centers or prime movers in the collaboration network. Smaller nodes and with fewer connections, such as Georgia Letton or Vaithianathan Rhema, show more limited involvement in collaboration. The dense network pattern with many connections between nodes indicates a high level of collaboration among authors in this network.

In conclusion, this visualization depicts the structure of author collaborations in the analyzed research community, providing insight into who are the main contributors and how collaborative relationships exist within the network. This is useful for identifying lead authors, potential collaborators, or collaboration centers in a particular field.

8. Inter-Institutional Collaboration Network

This image is a visualization of collaboration networks between institutions or departments based on analysis using VOSviewer. Each node represents an institution or department, while the lines connecting the nodes indicate the collaboration that occurs between them. The size of the node reflects the level of contribution or collaborative

activity of the institution, while the thickness of the connecting line reflects the strength of the collaborative relationship, which is calculated based on the number of joint publications.

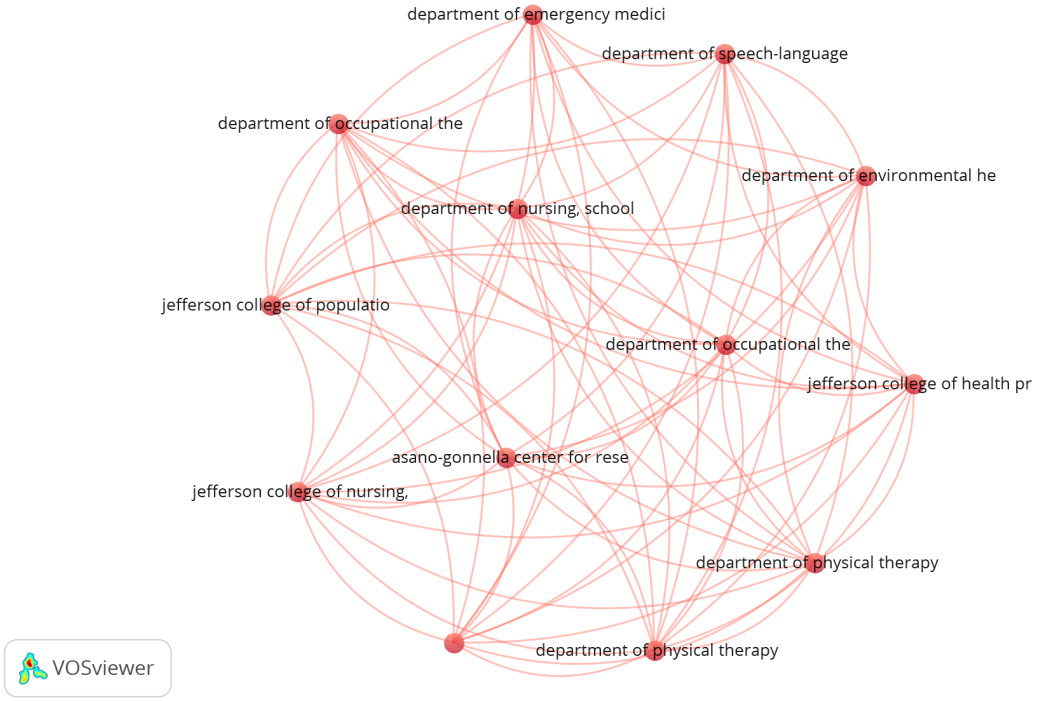

Figure 11. Inter-Institutional Collaboration Network

This image is a visualization of collaboration networks between institutions or departments based on analysis using VOSviewer. Each node represents an institution or department, while the lines connecting the nodes indicate the collaboration that occurs between them. The size of the node reflects the level of contribution or collaborative activity of the institution, while the thickness of the connecting line reflects the strength of the collaborative relationship, which is calculated based on the number of joint publications.

From this visualization, it can be seen that several departments such as the Department of Emergency Medicine, Jefferson College of Population, and Department of Nursing, School have quite significant connections with many other institutions, indicating that these institutions play an important role as collaboration centers in the research network. Departments such as the department of physical therapy and the department of occupational therapy also show strong collaborative involvement, especially with institutions that focus on health and education.

This network reflects the close level of collaboration between various institutions and departments, indicating strong synergies in research across fields such as health, environment and education. This visualization can be used to identify key institutions or departments leading the collaboration as well as opportunities to expand collaboration between departments or institutions that may not yet be directly connected. Overall, this network reflects an integrated pattern of cooperation between various parties in an effort to strengthen research results.

9. Inter-Country Collaboration Network

This image is a visualization of the collaboration network between countries based on analysis using VOSviewer. Each node represents a country, with the size of the node

indicating the amount of that country's contribution to the research collaboration. The connecting lines between nodes show the collaborative relationship between two countries, while the thickness of the lines describes the intensity or frequency of collaboration. The color of the nodes indicates groups (clusters) of countries that are closely linked in a collaboration network.

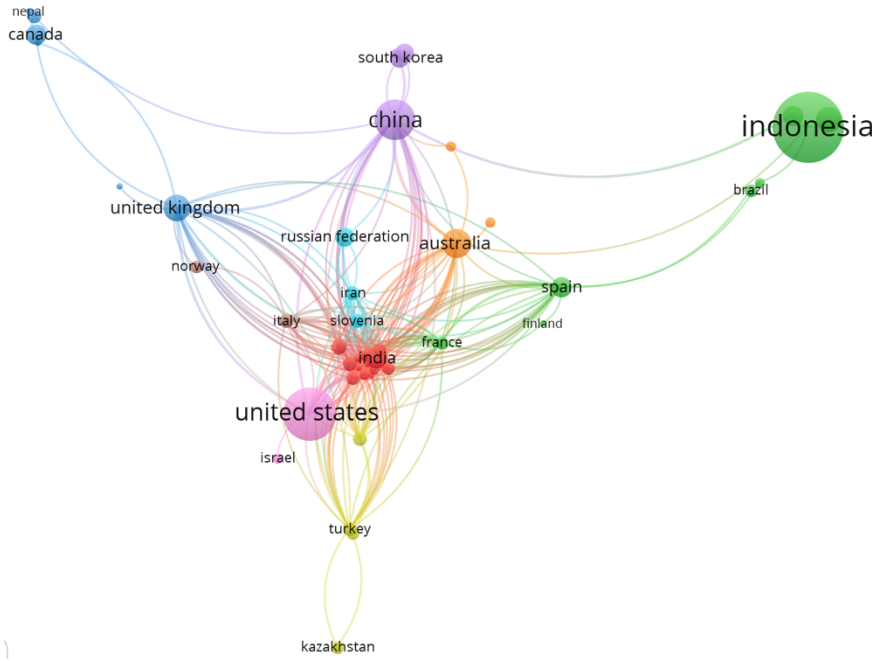

Figure 12. Inter-Country Collaboration Network

This image is a visualization of the collaboration network between countries based on analysis using VOSviewer. Each node represents a country, with the size of the node indicating the amount of that country's contribution to the research collaboration. The connecting lines between nodes show the collaborative relationship between two countries, while the thickness of the lines describes the intensity or frequency of collaboration. The color of the nodes indicates groups (clusters) of countries that are closely linked in a collaboration network.

From this visualization, it can be seen that countries such as Indonesia, the United States, China, and India have large nodes, indicating their significant role in the research collaboration network. Indonesia, with a green node, appears to be collaborating closely with countries such as Brazil and Spain, indicating cross-country cooperation in certain research. The United States as one of the major collaboration centers maintains ties with many countries including India, the United Kingdom, and Australia, reflecting major contributions in global research.

Meanwhile, countries such as Canada, South Korea, and Norway have smaller nodes, indicating more limited involvement, although they remain connected to key countries in the network. Relationships between countries in a particular group, such as a cluster involving China, India, and Russia, indicate a particular geographic or thematic focus in research collaboration.

Overall, this visualization illustrates the dynamics of international collaboration in research, showing the main countries leading the collaboration and the global networks that are forming. This provides insight into cross-border cooperation patterns and the potential for strengthening collaboration in the future.

Discussion

1. Trends and Challenges in Integrative Learning Models

The research results show that integrative learning models that combine numeracy literacy and character development are increasingly receiving global attention, with publication trends increasing since 2016 and peaking in 2024. Bibliometric analysis reveals that terms such as e-learning, digital literacy, and project-based learning are the main focus in this study, indicating that technology has an important role in implementing integrative learning models. The greatest contributions come from the fields of social sciences, computer science and education, which demonstrate a multidisciplinary approach in an effort to improve learning outcomes holistically.

However, there are several challenges in implementing this model, such as the lack of evidence-based learning models, variations in educational contexts, teacher readiness, and limited access to technology in some areas. The lack of experimental research that tests the effectiveness of this model is a major obstacle in understanding how integrative approaches can be implemented effectively in various educational settings. Therefore, more targeted strategies are needed in teacher training and innovation in the use of technology to support more effective learning.

2. Future Directions of Integrative Learning Models

As the educational landscape develops, the integration of numeracy literacy and character development becomes increasingly important. Future research should focus on refining and validating evidence-based integrative learning models that can be applied in a variety of educational contexts. With the emergence of digital learning platforms, the role of technology in supporting holistic learning is expected to become even greater. The combination of digital literacy tools with project-based learning models can improve not only cognitive skills, but also develop important character attributes such as responsibility, cooperation and perseverance. Longitudinal studies exploring the long-term impact of these integrative models on students' performance and their personal development will be indispensable to prove their effectiveness across educational systems and cultures. Additionally, future efforts should also focus on addressing the technology gap in education by ensuring equal access to digital resources, especially in less developed regions.

3. Improve Teacher Training for Integrative Approaches

A significant challenge that is still faced is how to adequately prepare educators to implement integrative learning models effectively. Teacher professional development must be adapted to the needs of the 21st century classroom, focusing not only on pedagogical skills but also technological skills. Evidence shows that when teachers are equipped with the right tools and strategies, they can significantly improve students' learning experiences (Gunawan et al., 2023). Therefore, collaborative teacher training programs that emphasize the integration of numeracy literacy and character development should be prioritized. These programs should incorporate innovative approaches such as blended learning, flipped classrooms, and the use of artificial intelligence for personalized learning pathways. By developing a deeper understanding of the interrelationships between these skills, teachers will be better equipped to educate students who are holistic and ready to face the challenges of an increasingly complex world.

4. Implications and Recommendations for Further Research

As an implication, closer collaboration is needed between academics, educators and educational technology experts to develop models that are more applicable and adaptive. Further research could focus on longitudinal analysis of the impact of integrative learning, comparison of the effectiveness of various strategies, as well as deeper exploration of the role of technology in supporting student character development. With an evidence-based approach and appropriate policy support, integrative learning models have the potential to be an effective solution in 21st century education.

CONCLUSION

This research aims to map global trends in integrative learning models that combine numeracy literacy and character development, to provide in-depth insight into the contributions of existing research and the gaps that need to be addressed.The method used is quantitative-based bibliometric analysis, with data collected from the Scopus database in the time period 2002–2024. Analysis was carried out using VOS viewer and R-Studio software to identify publication patterns, collaboration networks between authors and institutions, and dominant research themes. Research results show a significant increase in related publications since 2016, with a peak in research activity in 2024. Key findings indicate that the topics of numeracy literacy and character development are increasingly gaining global attention, with the largest contributions coming from the fields of social sciences, computer science, and education. Co-occurrence analysis reveals that terms such as "e-learning," "digital literacy," and "project-based learning" are the main focus in the integration of numeracy literacy and character development. The implication of this research is the need to develop evidence-based integrative learning models that can be adapted contextually to improve student learning outcomes holistically

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