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Uncovering Emerging Trends in Technology and Art Education: A Bibliometric Mapping Analysis

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ABSTRACT

The rapid advancements in technology have opened up new doors for both teachers and students to explore, learn, and create in innovative ways. However, this progress has also brought forth new challenges and complexities that demand a deeper understanding of the use of technology in art education. In this context, bibliometric analysis has emerged as a potent tool to examine emerging trends in the intersection of technology and art education. Employing the PRISMA approach (Preferred Reporting Items for Systematic Review and Meta-Analysis) and utilizing relevant Scopus databases with standardized procedures that ensure comprehensiveness and replicability, this bibliometric study identified 29 articles. The number of published articles in 2022, at 12, exceeded that of 2021, with only 6. Furthermore, the study highlighted the top 10 countries conducting research in technology and art education, with China having 17 studies, followed by the United States with 3 and Australia with 2. The top three keywords in current research trends are Education Computing, with 9 publications, E-learning, with 8, and Virtual Reality, with 7. Other keywords that relate to technology and art education are also pertinent to the research. These findings suggest that there is a growing interest in utilizing innovative research techniques to examine the intersection of technology and art education. As emerging technologies broaden the horizons of art-making and learning, they offer new avenues for creativity and innovation, but they also demand careful consideration of their potential benefits and risks. Educators and researchers will need to work in tandem to design effective strategies for integrating these technologies in ways that encourage creativity, learning, and social justice.

1. Introduction

Art education has always been an essential aspect of the curriculum, nurturing students' creativity and imagination [1]. Traditionally, it has focused on conventional forms of art such as painting, sculpture, printmaking, and drawing. However, the advancement in new technologies has brought about significant changes in art education, providing fresh opportunities for students to

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explore new modes of interaction and creation [2]. In recent times, the intersection between technology and art education has become increasingly popular. The increasing availability of digital tools and technologies such as computer graphics, virtual reality, and 3D printing has opened up new horizons for students to engage with art in innovative ways [3]. Art educators have thus begun to explore new methods of teaching and learning, incorporating digital media and technology.

One of the emerging trends in technology and art education is the use of digital tools and software to create and manipulate digital art. Adobe Creative Suite is an example of software that includes programs such as InDesign, Illustrator, and Photoshop [4]. This software enables students to create digital illustrations, graphic designs, and other forms of digital art. The integration of digital tools and software into art education provides students with opportunities to experiment with different mediums and techniques [5]. Another emerging trend in technology and art education is the use of virtual and augmented reality to enhance the art experience. Virtual reality provides an interactive, immersive experience for students to explore art and creative spaces. Augmented reality overlays digital information in the real world, creating a new way to interact with physical objects and spaces [6]. The use of virtual and augmented reality in art education provides students with a more engaging and interactive way of experiencing art.

The purpose of this study is to explore the emerging trends in technology and art education using bibliometric mapping analysis. Bibliometric analysis is a quantitative research methodology that provides a systematic approach to mapping the intellectual structure of a research field [7]. The methodology enables the identification of key research topics, the distribution of research output across institutions and regions, and the identification of gaps in the research. By analysing the existing literature on technology and art education, this study seeks to uncover the emerging trends in the field, identify areas of underdevelopment, and suggest potential avenues for future research.

This study holds immense significance in the domain of technology and art education, as it offers a holistic and in-depth comprehension of the current research trends in the field. The findings of this study can prove instrumental in guiding educators and researchers toward the latest emerging trends in technology and art education, and facilitate the development of effective strategies for integrating technology in art education. Additionally, the study will enable the identification of challenges and potential directions for future research, thereby contributing to the growth and advancement of the field. These studies suggest that researchers can gain a comprehensive understanding of the current state of technology in art education and identify emerging trends and research gaps that could inform future research and educational practices in the field.

Based on the literature below the research question will be answered in this review paper:

i. RQ1. What are the emerging trends in technology and art education based on a bibliometric analysis?
ii. RQ2. What is the most influential country in the field of technology and art education based on bibliometric analysis?
iii. RQ3. What keywords related to technology in art education vary across different regions, institutions, or populations according to bibliometric analysis?
iv. RQ4A. Based on bibliometric analysis, what research gaps exist in the literature on technology and art education?
v. RQ4B. How might the highlighted research shortcomings be addressed in future technological and art education studies?

3. Methodology

In this section, the methods and procedures for data collection and analysis are discussed, along with the development of a research framework and the identification of research questions that are appropriate for the study.

3.1 Bibliometric Analysis

Bibliometric analysis is a quantitative research methodology that provides a systematic approach to mapping the intellectual structure of a research field [8]. The methodology enables the identification of key research topics, the distribution of research output across institutions and regions, and the identification of gaps in the research. By analysing the existing literature on technology and art education, this study seeks to uncover the emerging trends in the field, identify areas of underdevelopment, and suggest potential avenues for future research.

3.2 PRISMA Approach (Preferred Reporting Items for Systematic Review and Meta-Analysis)

PRISMA stands for "Preferred Reporting Items for Systematic Reviews and Meta-Analyses." It is a set of guidelines developed by an international group of researchers and methodologists to improve the reporting of systematic reviews and meta-analyses [9]. The use of PRISMA guidelines in art education research can help to improve the quality and transparency of systematic reviews and meta-analyses and to ensure that they are reported in a way that is consistent and easy to understand. By following the PRISMA guidelines, researchers can also help to improve the reproducibility of their research, making it easier for others to replicate their studies and to build on their findings The use of the PRISMA approach enabled the identification of pertinent articles from Scopus databases that pertained to the research topic, and its systematic protocols ensured inclusivity and reproducibility. The inclusion criteria refer to the specific attributes that studies must fulfil to be deemed suitable for inclusion in the review. For this study, the inclusion criteria entailed the following:

i. Publication type: The scope of this study is limited to research articles only.
ii. Period: The time frame for this study is limited to articles published from 2019-2023.
iii. Research field: The focus of this study is on the integration of technology in art education.
iv. Language: English

To ensure the relevance and accuracy of the analysis, certain exclusion criteria were applied to the selection of publications for this bibliometric study. Firstly, publications that were not directly related to the research topic or question were excluded. This means that only publications within the field of art education, with a focus on technology applications, were considered. Secondly, publications that were not written in English were also excluded. This was necessary to ensure the consistency and clarity of the data analysis. Thirdly, publications that lacked essential bibliometric information such as the author's name, publication date, or growth of research output were also excluded. Finally, to prevent duplicate data, publications that appeared in multiple databases or sources were excluded from the analysis. These exclusion criteria were applied to refine the analysis and ensure that the results were relevant and reliable. Figure 1 showing the PRISMA flowchart of data inclusion and exclusion.

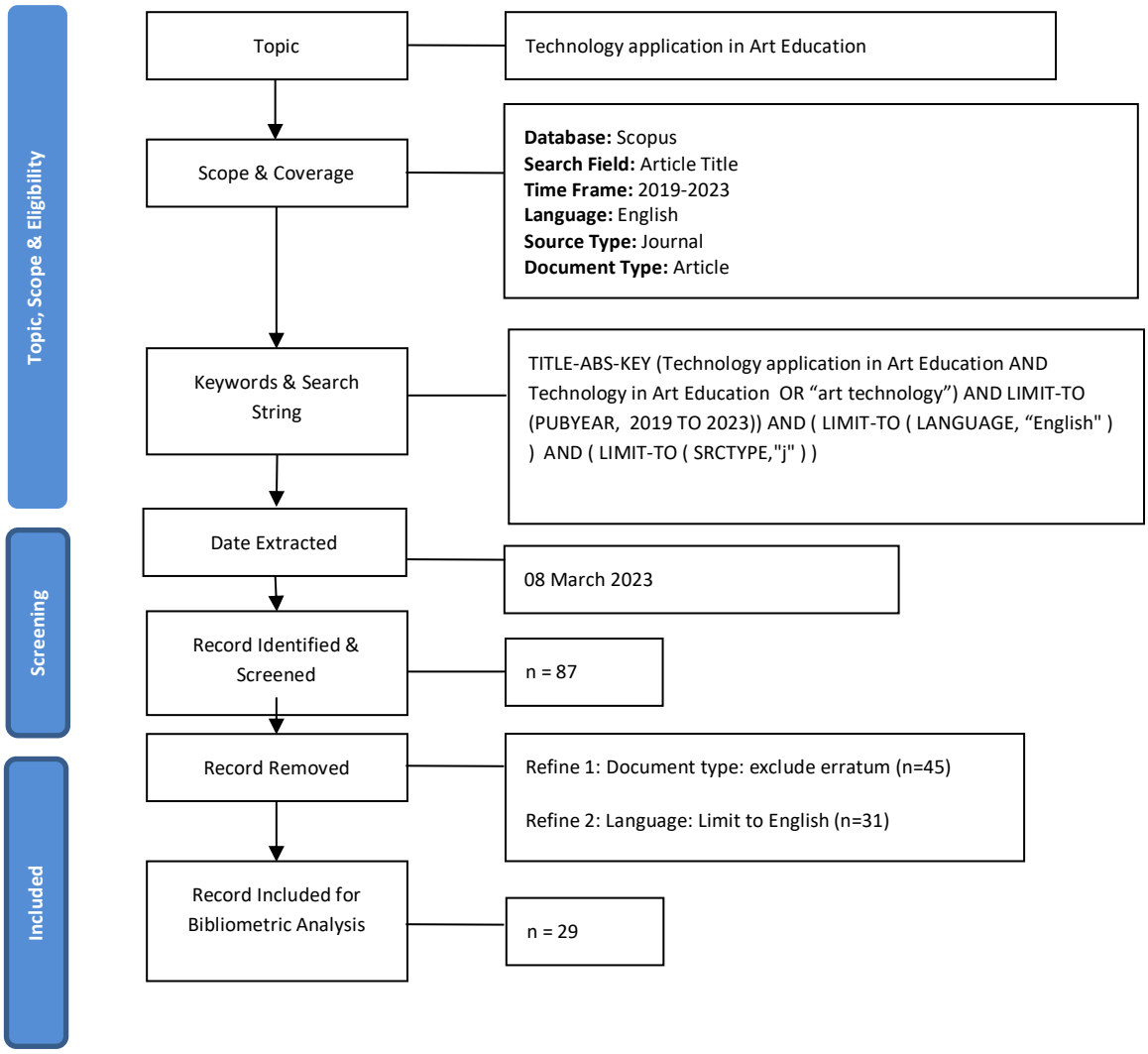


Fig. 1. PRISMA flowchart of data inclusion and exclusion [10]

3.3 VOS (Visualization of Similarities)

VOS, which stands for "visualization of similarities," is a bibliometric analysis technique used to generate visual representations of the relationships between research publications. Its use in art education has proven to be beneficial due to its ability to explore the intricate networks of ideas and concepts in the field [11]. By creating different visualizations such as citation networks, co-authorship networks, and keyword networks, VOS helps to identify the most critical themes and concepts in art education, as well as the most influential works and authors [12]. This information can be utilized by educators to design curricula that are more targeted and engaging for students [13]. Overall, VOS is a valuable tool for enhancing the understanding of complex networks of ideas and concepts in art education.

3.4 Bibliometric

Bibliometric analysis is a technique used to measure the impact and influence of research publications by analysing quantitative data such as citation counts and authorship networks. In the context of art education, bibliometric analysis can be employed to identify significant concepts,

themes, and trends in the field, and to map out connections between different ideas and approaches. By analysing citation counts and other bibliometric data, educators can identify frequently cited works and authors, as well as important concepts and themes, which can be used to design curricula grounded in the latest research. Additionally, bibliometric analysis can help to identify gaps in knowledge and areas that require further research, aiding educators in developing new courses or programs in the field [14].

4. Findings

4.1 Progressed in the Publication on Technology Application in Art Education

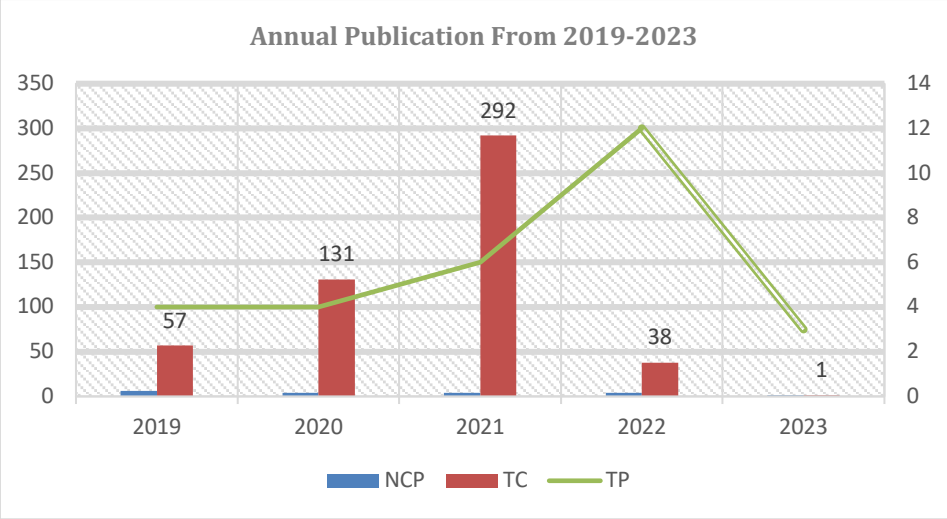
A total of 29 articles were included in this study using the PRISMA approach and were retrieved from the Scopus database. Scopus was selected for this study as it is recognized as a high-quality and impactful database, meeting strict criteria for scholarly publishing such as peer review and editorial standards. The results show in Table 1 that all 29 articles are published as articles. The findings reveal that 41.38% of the total number of articles (12 articles) were published in 2022, while 6 articles were published in 2021. This indicates a growing interest in integrating technology into art education and exploring new ways to enhance the learning experience using technological tools and platforms. The total number of cited papers (NCP) was 19, with a total citation count (TC) of 519, and a citation per cited paper (C/CP) of 125.75, confirming an increase in research in the field of technology application in art education. Furthermore, Table 1 shows that 12 articles are indexed in h and 22 articles are indexed in g, which are commonly used metrics to assess the impact and productivity of researchers, although these metrics have been subject to criticisms and limitations.

Table 1
Annual Progress on Publication of Technology Application

Year	TP	%	NCP	TC	C/P	C/CP	h	g
2023	3	10.35	**1**	1	0.33	1.00	1	1
2022	12	41.38	**6**	57	4.75	9.50	2	7
2021	6	20.69	**4**	131	21.83	32.75	3	6
2020	4	13.79	**4**	292	73.00	73.00	3	4
2019	4	13.79	**4**	38	9.50	9.50	3	4
Total	29	100.0%	**19**	519	109.41	125.75	12	22

*Total Publication (TP), Number of Cited Publication (NCP), Total Citation (TC), Citation Per Paper (C/P), Citation per Cited Paper (C/CP), Hirsch index (-h), G index (-g)

Finally, Figure 2 shows the Annual Progress on Publication of Technology Application in Art Education.



*Total Publication (TP), Number of Cited Publication (NCP), Total Citation (TC), Citation Per Paper (C/P)

Fig. 2. Annual Progress on Publication of Technology Application in Art Education

4.2 Bibliometric Productivity Trend in Technology Application in Art Education

The study utilized bibliometric analysis to identify the top 10 countries that have conducted research and published articles on technology and art education. The analysis revealed in Table 2 that China has published the highest number of studies, accounting for 58.62% (17 studies) of the total output. The United States ranks second with 3 articles (10.34%) published, followed by Australia, Hong Kong, India, Malaysia, and the United Kingdom, which each published two articles (6.90%). These results suggest that China places greater emphasis on integrating technology into education compared to other countries, possibly due to its education system's emphasis on academic achievement and research. Despite that, it shows also that China has expand their interest and effort in this research area. However, other countries are also increasing their research output to keep pace with developments in the field of art education and technology. Emerging trend in this fields shows that more opportunity to integrate studio practice with technology that paving path for a new methodology in art education by crossing boundaries into new media and skills. Country analysis helps to identify the leading nations in scientific research and development.

Table 2
Top Ten Country on Technology Application in Art Education

Country	TP	%
China	17	58.62
United States	3	10.34
Australia	2	6.90
Hong Kong	2	6.90
India	2	6.90
Malaysia	2	6.90
United Kingdom	2	6.90
Chile	1	3.45
Jordan	1	3.45
Lithuania	1	3.45

*Total Publication (TP)

This helps to determine global research trends and areas of scientific advancement. Finally. Figure 3 shows the Top Ten Countries Productivity on Technology and Art Education.

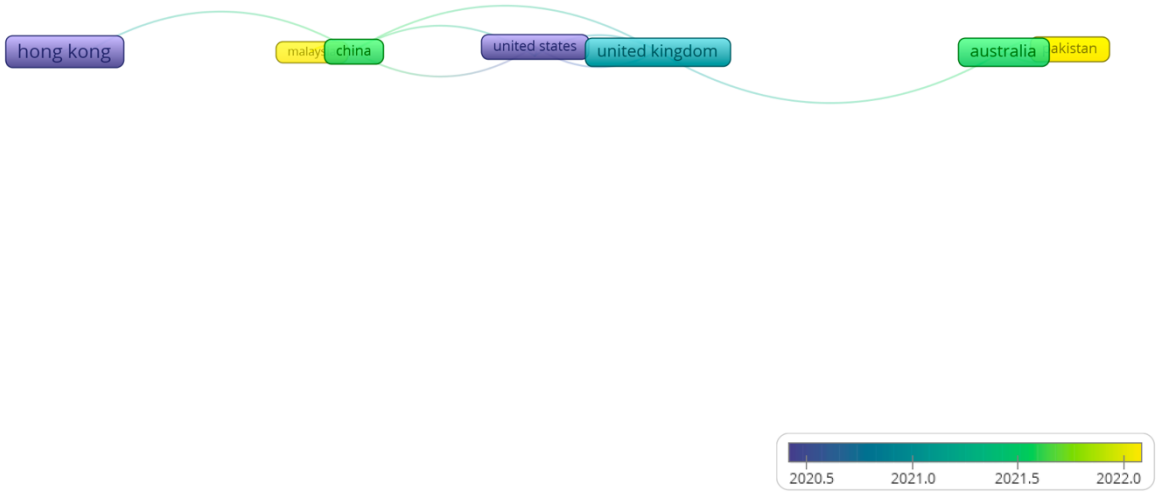


Fig. 3. Top Ten Countries Productivity on Technology and Art Education

4.3 The Main Keywords of the Technology Application in Art Education Research

According to bibliometric analysis, the top ten keywords that are currently the main focus of research in technology application in art education have been identified. As showed in the Table 3; The largest keyword among them is Education Computing, with a total of 9 publications (31.03%), followed by E-learning with 8 publications (27.59%) and Virtual Reality with 7 studies (24.14%). These findings suggest that researchers are exploring new ways to incorporate technology into art education, such as through online learning and virtual reality experiences. The increasing integration into art education reflects the changing landscape of education and the need for educators to adapt to new technologies to enhance the learning experience for students.

Table 3
Top ten keywords on technology application in art education

Keyword	TP	%
Educational Computing	9	31.03%
E-learning	8	27.59%
Virtual Reality	7	24.14%
Curricula	6	20.69%
Teaching	6	20.69%
Education	5	17.24%
Learning Systems	5	17.24%
Virtual Reality Technology	5	17.24%
Integration	4	13.79%
Art Teachings	3	10.34%

*Total Publication (TP)

Finally. Figure 4 shows the VOSviewer visualization map of the author keywords.

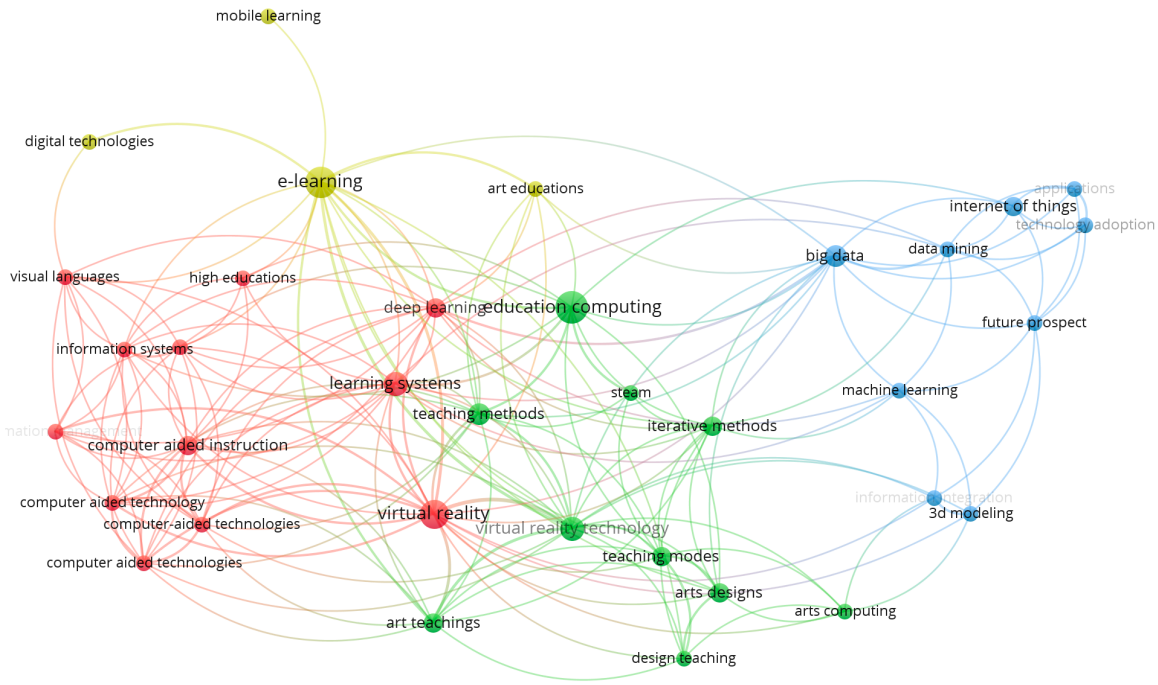


Fig. 4. VOSviewer visualization map of the author keywords

5. Discussions

5.1 RQ1. What are the Emerging Trends in Technology and Art Education Based on a Bibliometric Analysis?

The increasing publication on technology application in art education can be attributed to several reasons. Firstly, technology has become an essential component of our daily lives, including the education sector [15]. With the advancements in technology, new tools and platforms are being developed to enhance the learning experience in art education [16]. Secondly, there is a growing demand for innovative and engaging teaching methods that can capture students' interest and encourage their creativity. Technology can offer new and exciting ways for students to express themselves creatively, and educators are increasingly exploring these possibilities [17]. Lastly, the COVID-19 pandemic has accelerated the integration of technology into education. Many educational institutions have had to switch to online learning, highlighting the importance of technology in education and leading to an increase in research on technology applications in art education [18].

5.2 RQ2. Which Country Has the Most Influence in the Field of Technology and Art Education Based on Bibliometric Analysis?

The higher productivity pattern in technology application in art education in China compared to other countries like Australia, Hong Kong, India, and Malaysia could be due to several factors. One of these is the significant investment in research and development in the area of educational technology by the Chinese government [19]. This investment has had a positive impact on the education system, including the integration of technology in teaching and learning. Another potential explanation is the culture of collaboration and networking among researchers and educators in China [20]. Collaborative projects and partnerships between universities and other institutions have likely contributed to a culture of innovation and knowledge-sharing in the field of art education and technology, leading to higher productivity [21].

5.3 RQ3. How Do Most Commonly Used Keywords Connected to Technology in Art Education Vary Across Various Regions According to Bibliometric Analysis?

The keywords Education Computing, E-learning, and Virtual Reality are commonly used in academic publications because they are related to the intersection between technology and education. Education Computing refers to the use of technology to enhance teaching and learning [22]. E-learning involves the use of electronic media and technology to facilitate learning, which has become increasingly relevant due to online education and distance learning [23]. Virtual Reality enables users to experience a simulated environment and has many applications in education, such as providing immersive learning experiences and training simulations [24]. These keywords are relevant to a wide range of disciplines and fields and are likely to continue to be an important area of research and innovation. The future direction of technology in art education is likely to be shaped by advancements in digital technologies, an increased focus on personalized and immersive learning experiences, and a growing emphasis on sustainability and global collaboration [25]. Educators who can embrace these trends and adapt their teaching methods accordingly are likely to be well-positioned to help their students succeed in a rapidly changing world [26].

5.4 RQ4A. Based on Bibliometric Analysis, What Research Gaps Exist in the Literature on Technology and Art Education?

Various gaps are associated with the effective use of technology applications in art education, as indicated by the Bibliometric analysis. These gaps include:

i. Access and equity: One of the most significant challenges to using technology in art education is ensuring that all students have access to the necessary equipment, software, and internet connectivity. This can be particularly challenging in schools or communities with limited resources or where students come from disadvantaged backgrounds [27].
ii. Pedagogical issues: Another challenge is ensuring that the use of technology aligns with sound pedagogical principles and supports the learning goals of art education. Teachers may struggle to integrate technology in a way that supports creativity, critical thinking, and problem-solving skills, rather than simply replacing traditional art-making techniques [28].
iii. Technical issues: Technical issues, such as hardware or software malfunctions, can also hinder the effective use of technology in art education. Teachers may not have the technical expertise to troubleshoot problems, and technical support may be limited [29].
iv. Assessment and evaluation: There is a need to develop effective ways to assess and evaluate the impact of technology on student learning in art education. Traditional assessment methods may not be well-suited to evaluating creative and innovative uses of technology in the classroom [30].

5.5 RQ4B. How Might the Highlighted Research Shortcomings be Addressed in Future Technological and Art Education Studies?

The future direction of technology application in art education is likely to focus on the development and implementation of new and innovative technologies. Here are some potential directions for the future of technology application in art education:

i. Continued development of virtual and augmented reality tools: Virtual and augmented reality tools have the potential to revolutionize the way art is taught and experienced. As technology continues to advance, we can expect to see more sophisticated and user-friendly VR and AR tools developed specifically for art education.
ii. Increased use of artificial intelligence (AI) in art education: AI has the potential to assist with everything from grading assignments to generating new ideas and concepts for art projects. As AI technology becomes more advanced, we will likely see an increase in its use in art education.
iii. Integration of technology with traditional art-making techniques: While there is certainly value in teaching traditional art-making techniques, technology can also be used to enhance and expand upon these techniques. For example, students could use digital tools to create and manipulate images before transferring them to a physical medium.
iv. Collaboration between art and technology experts: As technology becomes increasingly integrated with art education, we can expect to see more collaboration between artists and technology experts. This collaboration can lead to the development of new tools and techniques that are specifically tailored to the needs of art educators and students.
v. Greater focus on accessibility: Technology has the potential to make art education more accessible to students with disabilities, as well as those in remote or underserved areas. As technology continues to develop, we can expect to see a greater emphasis placed on making art education accessible to all students, regardless of their circumstances.

All of these patterns, significant nations, and keywords impact future research topics in bibliometric analysis by informing research questions, study design, and interpretation of results. By identifying the significant nations in a technology and arts research area, researchers can focus on collaborations with researchers from those nations or identify potential gaps in research that can be addressed by those nations. Additionally, by analysing the keywords that emerge from technology and arts research, researchers can identify emerging trends in technology and. Finally, by examining technology and arts patterns in publication and citation data, researchers can identify areas of research that are underrepresented or in need of further investigation. In summary, patterns, significant nations, and keywords that emerge from bibliometric analysis can provide valuable insights into the research landscape and impact future research topics by informing research questions, study design, and interpretation of results.

6. Conclusion

In conclusion, technology is playing an increasingly important role in art education, with many educators and researchers exploring innovative ways to incorporate new tools and techniques into the curriculum. Bibliometric mapping analysis can provide a valuable tool for identifying emerging trends in this field, as well as highlighting areas where further research is needed. Some of the key research questions that could be explored in future studies include the evolution of technology in art education, the most popular types of technology used in different regions and populations, the most effective research methods for studying technology and art education, and the major challenges and barriers that must be addressed to ensure that technology is used effectively in this context. As emerging technologies continue to develop, such as virtual reality and artificial intelligence, it will be important to explore how these tools can be integrated into art education and what implications they may have for the field. By addressing these questions and others, researchers and educators can help ensure that art education remains relevant and effective in the 21st century. The bibliometric

mapping analysis concluded that art education is essential in the twenty-first century as it promotes creativity, critical thinking, cultural understanding, and personal and social development. It prepares individuals for future careers that require innovation and adaptability and fosters a more peaceful and equitable society. Integrating technology in art education can provide students with new opportunities to learn and create, and also helps them to develop digital literacy skills that are essential in today's world.

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