Analysis of Computational Bibliometric Mapping in Multimedia for Art Learning Media Publications using VOSviewer

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ARTICLE INFO	ABSTRACT
	This research explores the development of fine arts learning media using interactive multimedia research. The goal can be a reference for researchers in conducting and defining research themes, especially around multimedia learning. The method is used through a bibliographic approach with computational mapping analysis using VOSviewer. Article data is retrieved from the Google Scholar database using a publish-or-perish reference management application. Article titles and abstracts serve as guidelines when searching for keywords like "art," "learning media," and "multimedia." We found 447 seemingly related articles. The study period used as learning material is a paper from the last five years (2018 to 2023) indexed by Google Scholar. The results of research on fine arts learning media using interactive multimedia can be classified into four terms. The first term "Training" belongs to cluster 2 with a total of 34 links, an overall link strength of 138, and 59 events. The second term, "Media", belongs to cluster 2, with a total of 30 links, an overall connection strength of 142, and 74 events. The third term, "Multimedia", belongs to cluster 2, with a total of 27 links, an overall connection strength of 110, and 55 events. The fourth term "art" belongs to cluster 1 with a total of 34 links, an overall link strength of 138 and 59 events. From 2018 to 2020, the survey found research fluctuations in several media-based art learning media studies (65, 110, and 124 publications per year, respectively). The number of studies decreased from 44 (2021) to 16 (2023) from 2021 to 2023. Thus, there are still many opportunities for researchers to discuss it.

1. Introduction

The development of technology and information in Indonesia has provided great benefits for all of its people [1], especially the benefits of information through internet web literacy which plays a role in increasing knowledge for educators and students [2] in increasing insight into today's technology-based learning [3]. It is important for educators to apply the correct learning format when teaching students [4]. The arts sector is also experiencing good developments in terms of materials, techniques and technology-based media to meet the needs of the 21st century population. Fine art

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is a field of art that continues to develop and meets the needs of humanity in the 21st century. Technology plays a very important role in the industrial era [5], especially in the development of materials, techniques, media, art exhibitions and performances [6].

Multimedia is a combination of elements such as text, images, sound, and video in one platform. In art learning media, multimedia enhances students' learning experience. Using multimedia, students can interact with the material, see the artist's creative process, and gain a deep understanding of the concept of art. Multimedia also provides flexibility of access and motivates students to actively participate in learning. Thus, multimedia has an important role in improving the quality of fine arts learning with an interesting, interactive, and comprehensive learning experience for students, and it also has substantial impact on students. [7] The use of multimedia-based fine arts learning media in schools brings significant benefits [8]. Teachers can conduct more engaging presentations and demonstrations using images, video, and audio. Students can access art resources digitally and dig into famous artworks. They can also create digital artwork and collaborate with classmates. Multimedia media facilitates the evaluation and assessment of students' artwork. With the integration of technology in art teaching, students can develop creativity, a deeper understanding of art, and interactive learning experiences [9]. Furthermore, by using multimedia content, such as animations and audiovisuals, will make the learning experience more dynamic and engaging [10].

One analytical technique that can be used to determine the progress of research in the field of learning is bibliographic analysis. Bibliographic analysis is a form of meta-analysis of research data that helps researchers examine bibliographic content and analyse citations from articles published in journals and other scientific studies [10].

There have been many studies on bibliometric analysis, in the field of learning and media, including bibliometric analysis on the Development of Physics Learning Media [11], Ethnomathematics in Mathematics Learning [12], Trends in the Use of ICT in Mathematics Learning [13], Indonesian learning [14], Augmented Reality in Mathematics Education [15], Technology-Based Biology Learning Media [16], Bibliometric Learning Media in Elementary Schools [17], Digital Learning Media [18], Game-based physics learning [19], Making Motion Graphics as Media [20], Technology-Based Learning [21], Google Classroom Learning [22], physics learning practices [23], Librarian Digital Literacy Research [24], Use of Learning Videos [25], Game-Based Learning [26], Teacher Creativity Research in Mathematics Learning [27], Ethnomathematical Terms [28], Interactive learning media [29], Challenges and opportunities in education [30], Scientific argumentation about science learning [31], about mathematical reasoning skills [32], and Mathematical Critical Thinking Skills [33].

However, computational mapping studies, bibliographic analysis, and data for the development of publications in multimedia learning media are carried out in various ways [34]. Bibliographic analysis of the last five years of research from 2018 to 2023 using the VOSviewer application. This research was conducted to conduct a computational study of mapping the bibliographic analysis of papers indexed by Google Scholar using VOSviewer software [35].

This research was conducted with the aim of being a reference for researchers in conducting and defining research themes, especially around multimedia learning, because the results of research from other researchers can be an idea in determining new research themes [36] so as to enrich scientific discussions about multimedia learning media in the future.

Novelty research on multimedia art learning media from 2018 to 2023 all articles were cited as many as 1004 quoters. The development of articles fluctuates and tends to decrease. Although there was an increase from 2018 to 2020 (65, 110, and 124), there was a drastic decline from 2021, 2022, and 2023 (88, 44, and 16), so there are still many opportunities for researchers to discuss it.

2. Methodology

The article data used in this study is based on research from publications published in Google Scholar indexed journals. We chose Google Scholar for this study because the Google Scholar database is open source. Reference management applications such as Publish or Perish are used to capture research data. Use 'Publish or Perish' software to conduct a literature survey on a topic of your choice. Detailed information on how to use and install the software, as well as step-by-step instructions [37], and library searches when searching data with Google Scholar, were provided in previous research by Azizah *et al.,* explain [38]. The study was conducted through several stages:

i.   Collection of publication data using the publish application or perish,
ii. Processing of bibliometric data of articles that have been obtained using the Microsoft Excel application,
iii. Computational mapping analysis of bibliometric publication data using the VOSviewer application, and
iv. Analysis of the results of computational mapping analysis.

The 'Publish or Perish' article data search filters publications based on the keyword's 'art', 'learning media' and 'multimedia'. Based on the publication title requirements. The works used were published between 2018 and 2023. All data is collected by July 2023. Papers collected that meet the research analysis criteria are exported into two file types: Research Information System "ris" and comma-separated value format (*.csv). VOSviewer also allows you to visualize and assess trends using bibliographic maps. Then the item data from the source database is mapped.

VOSviewer is used to create variations of its three mapping publications: network visualization, density visualization, and overlay visualization based on networks (co-citations) between existing elements. When creating a bibliographic map, it determines how often a keyword is found at least 3 times. As a result, 271 irrelevant terms and keywords were removed.

3. Results
3.1 Publication Data Search Results

Table 1 appears based on data retrieval by the Publish or Perish Reference Manager application from the Google Scholar database [39], 447 data articles that meet the research criteria were taken. The data taken is in the form of article metadata consisting of author name, title, year of publication, journal name, publisher, number of citations, article links, and related URLs. Table 1 shows some examples of published data used in VOSviewer analysis for this study. The sample data consisted of 19 excellent papers with high relevance and the highest number of citations. All papers used in this study had 1004 citations, 100.40 annual citations, 2.06 citations per paper, the average paper authors used was 2.46, and the average h-index for all papers. is 12 and G-index is 17.

Table 1
Article and citation data from publish or perish applications

No.	Authors	Title	Year	Cites
1	R Rachmadtullah, Z Ms, MS Sumantri	Development of computer-based interactive multimedia: study on learning in elementary education	2018	159
2	P Leszczyński, A Charuta, B Łaziuk...	Multimedia and interactivity in distance learning of resuscitation guidelines: a randomised controlled trial	2018	149
3	VH Saputra, E Febriyanto	Multimedia-Based Learning Media for Children with Intellectual Disabilities	2019	147
4	S Hadisaputra, G Gunawan...	Effects of Green Chemistry Based Interactive Multimedia on the Students' Learning Outcomes and Scientific Literacy	2019	137
5	Q Li, Z Li, J Han	A hybrid learning pedagogy for surmounting the challenges of the COVID-19 pandemic in the performing arts education	2021	106
6	J Katz-Buonincontro	Gathering STE(A)M: Policy, curricular, and programmatic developments in arts-based science, technology, engineering, and mathematics education Introduction to the special issue of Arts Education Policy Review: STEAM Focus	2018	93
7	LN Amali, N Zees, S Suhada	Motion graphic animation video as alternative learning media	2020	76
8	R Rahmatika, M Yusuf, L the Great	The effectiveness of YouTube as an online learning media	2021	69
9	P Manurung - Al-Fikru	Interactive Multimedia as a Learning Media During the Covid 19 Pandemic	2020	67
10	MD González-Zamar, E Abad-Segura	Implications of virtual reality in arts education: Research analysis in the context of higher education	2020	63
11	RP Wibawa, RI Astuti, BA Pangestu	Smartphone-Based Application â€ œquizizzâ€ as a Learning Media	2019	62
12	M Saputra, TF Abidin, BI Ansari...	The feasibility of an Android-based pocketbook as mathematics learning media in senior high school	2018	59
13	C Hadza, A Sesrita, I Suherman	Development of Learning Media Based on Articulate Storyline	2020	58
14	M Ediyani, U Hayati, S Salwa...	Study on Development of Learning Media	2020	41
15	PPS Dita, S Utomo, DA Sekar	Implementation of Problem Based Learning (PBL) on interactive learning media	2021	39
16	RA Pratiwinindya	Interactive Media Recognizes Classic Batik Motifsâ€ in Learning Batik Appreciation for Elementary School Students	2019	21
17	Stephan Schwan, Silke Dutz, Felix Dreger	Multimedia in the wild: Testing the validity of multimedia learning principles in an art exhibition	2018	19
18	SN Handayani, S Sihkabuden	Development of interactive multimedia East Java dance in class VII cultural arts subjects at SMP Negeri 1 Karangan	2018	13
19	K Duwika, KW Paramasila	Development of Interactive Multimedia Hybrid Model with Balinese Character Nuances "Cupak-Gerantang" in Learning 2-Dimensional Animation Techniques	2019	13

3.2 Development of Research in the Field of Multimedia Art Learning

Table 2 and Figure 1 show the development of research in the field of multimedia learning media published in Google Scholar indexed journals [40]. The data presented in Table 2 and Figure 1, show that the number of multimedia learning media pedagogy research from 2018 to 2023 is 447. In 2018, there were 65 publications in multimedia learning media. In 2019, this number increased significantly to 110, indicating an increased interest and focus on this topic. By 2020, the number of publications

will reach 124, indicating a growing trend of interest in multimedia learning media topics. However, the number of publications in 2021 decreased slightly to 88. Although declining, this value is still relatively high compared to 2018. In 2022, the number of publications dropped significantly to 44, indicating a significant decrease in interest in the topic. This decline can be caused by a variety of factors, including shifts in research interest to other topics and changing trends in the field of multimedia learning media.

Table 2
Development of research in the field of multimedia art learning education research

Year of Publications	Number of Publications
2018	65
2019	110
2020	124
2021	88
2022	44
2023	16
Total	447
Average	74.5

After 2023, there will be only 16 publications on this topic. This figure shows that the number of publications in multimedia learning media will decrease further in 2023 compared to the previous year. However, full data for 2023 is needed to get a more complete picture of year-over-year trends.

Overall, we can say that interest in multimedia learning media clearly increased from 2018 to 2020, but decreased significantly in the following years. This decline may be due to a shift in research interest to other areas or a decrease in interest in using multimedia learning media.
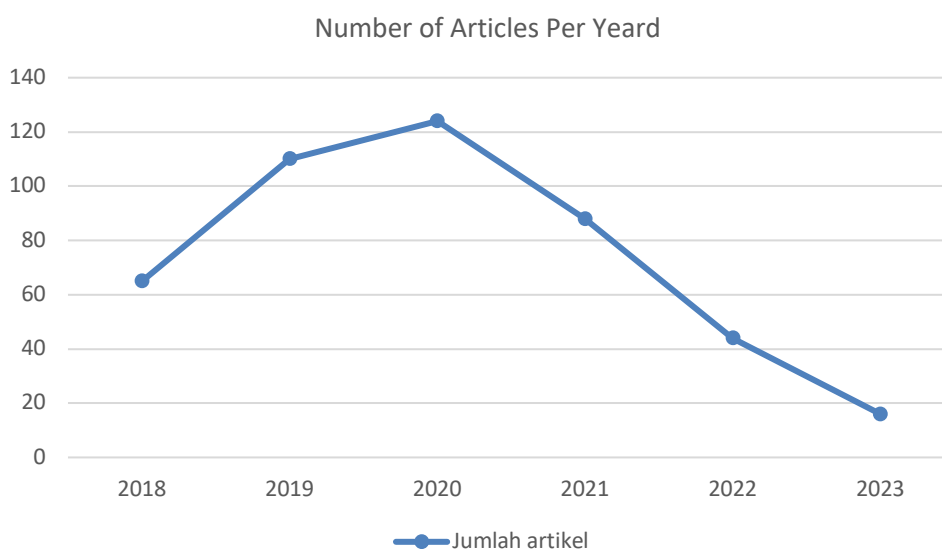

Fig. 1. Level of development in multimedia for art learning media research

3.3 Visualization of Multimedia-Based Art Learning Media Topic Area using VOSviewer

Arithmetic tasks are based on article data. VOSviewer is used for computational mapping. Found 71 elements from the results of computational mapping. Each item related to multimedia-based fine arts learning media in data mapping falls into one of its five groups:
Figure 2 shows an overview of the number of clusters and the number of terms:

   i.   Cluster 1 (32 items): architecture, art review, art survey, art technology, art therapy, artificial intelligence, blockchain, challenges, current state, deep learning, future direction, future perspective, future prospects, industry, internet, jace country, life, literature, machine, leamina machine, multimedia thing, nature, opportunity, overview, patient, person, last year, review, science
  ii.   Cluster 2 (13 items): computer, effectiveness, interactive multimedia, multimedia, learning, medium, multimedia, multimedia technology, product, student, teacher, teaching
 iii.   Cluster 3 (11 items): age, art historian, art history, author, book, child, contemporary art, culture, examples, history, world
  iv.   Cluster 4 (9 items): images, types, multimedia applications, multimedia content, multimedia data, multimedia services, text, video
   v.   Cluster 5 (6 items): effects, emotions, environment, learner, multimedium, principles.

Grouping analysis can reveal how related terms relate to each other and form groups [41] based on subject matter. In this case, cluster groups can highlight gaps between concepts while providing an overview of key themes and related aspects.

Cluster 1 includes terms related to the development and direction of multimedia art learning media in the future. B. Art Technology, Artificial Intelligence, Prospects and Opportunities. Cluster 2 focuses on concepts related to the teaching and learning process in the context of multimedia art learning media, such as effectiveness, education, and interactive multimedia. Cluster 3 deals with aspects of history, culture, and art education in multimedia art learning media, using terms such as art history, contemporary art, and writers. Cluster 4 focuses on the use and nature of multimedia content in art learning media such as: B. Multimedia applications, images, videos, text. Cluster 5 contains terms related to Emotional Influence, Learning Environment, and Learning Media Principles Multimedia.

By examining the clustered groups formed, we can see that clustering is done based on themes and generalizations that are interrelated in the environment of the appearance of terms in the composition. It helps in connecting connections and gaps in the exploration and development of multimedia-based art literacy media.

Fig. 2. Term mapping by cluster

Markers are assigned to each term with multi-coloured circles. The size of the circle for each cluster varies depending on the frequency of the cluster state. The size of the marker circle shows a positive correlation with the state of the term in the title and abstract. The more often the term is set, the larger the size of the marker. The anatomized mapping visualization in this study consists of 3 corridor network visualization (see Figure 3), viscosity visualization (see Figure 4), and overlay visualization (see Figure 5) [42].

Figure 3 shows a visualization of network density. Density visualization shows that the brighter the yellow colour and the larger the diameter of the circle of the term label, the more common the term is [43], which suggests that a lot of research has been done on related terms. Conversely, if the colour of a term fades towards the background colour, it means that research effort for that term is low. It also shows that there is quite a lot of research on the terms learning, media, multimedia and art (art review). The relationship between words is shown in Figure 3. Interconnected networks describe the relationship between words. Figure 3 also illustrates a cluster of each phrase that is commonly explored and associated with problems in learning multimedia art learning media.

Fig. 3. Network visualization of the multimedia art learning media keyword

Figure 4 shows Bright colours used in terms such as learning, media, art, and multimedia. This suggests that the use of bright colour-related terms in the context of research is associated with an increase in the number of studies. These terms refer to topics that receive active attention. The use of these terms reflects the prevalence of learning, media, art, and multimedia studies in these fields. On the other hand, fading-related terms such as "learning media" and "art learning media" do not appear at all. These terms reflect a small amount of research related to art learning media. The use of these terms indicates a lack of research interest or poor indexing of the topic by Google Scholar.

Fig. 4. Viscositas visualization of multimedia art learning keyword density

The cluster in network visualization shows that multimedia-based art learning media research can be divided into four areas, with the term learning included in cluster 2 having 34 linkages, a total of

138 connectedness strengths, and 59 events.
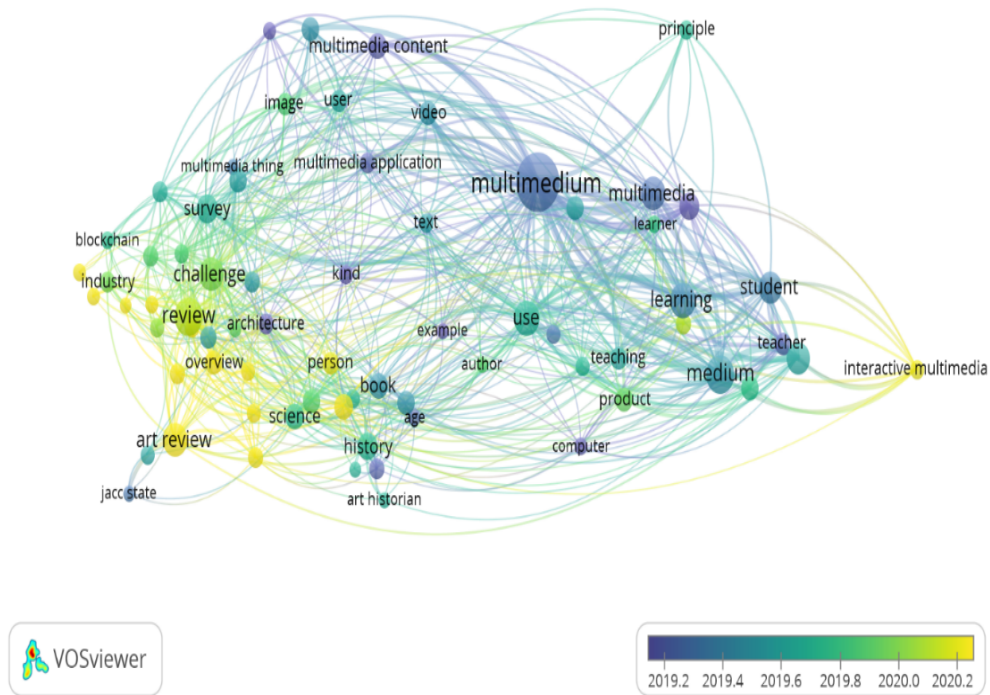
Fig. 5. Overlay visualization of multimedia for art learning media keyword

Figure 6 illustrates this. The second word is the media of cluster 2 with the number of links 30, the total link strength 142, and the occurrence of 74 (see Figure 6), and the third term is multimedia from group 2 with a total of 27 links, the total link strength is 110, and event 74, as well as 55 events (see Figure 7).

| Item: learning | Cluster: 2 | Links: 34 | Total link strength: 138 | Occurrences: 59 |

Fig. 6. Item 1: learning

Figures 5, 6, and 7 also show a network of terms such as learning, multimedia, and media in related groups. These three terms are related to other terms such as student, media, multimedia, interactive multimedia, teacher, product, child, author, learner, principle, multimedia technology, multimedia application, environment, book, world, artificial intelligence, art review, research., video, text, use, science, review, overview, can be explained as follows:

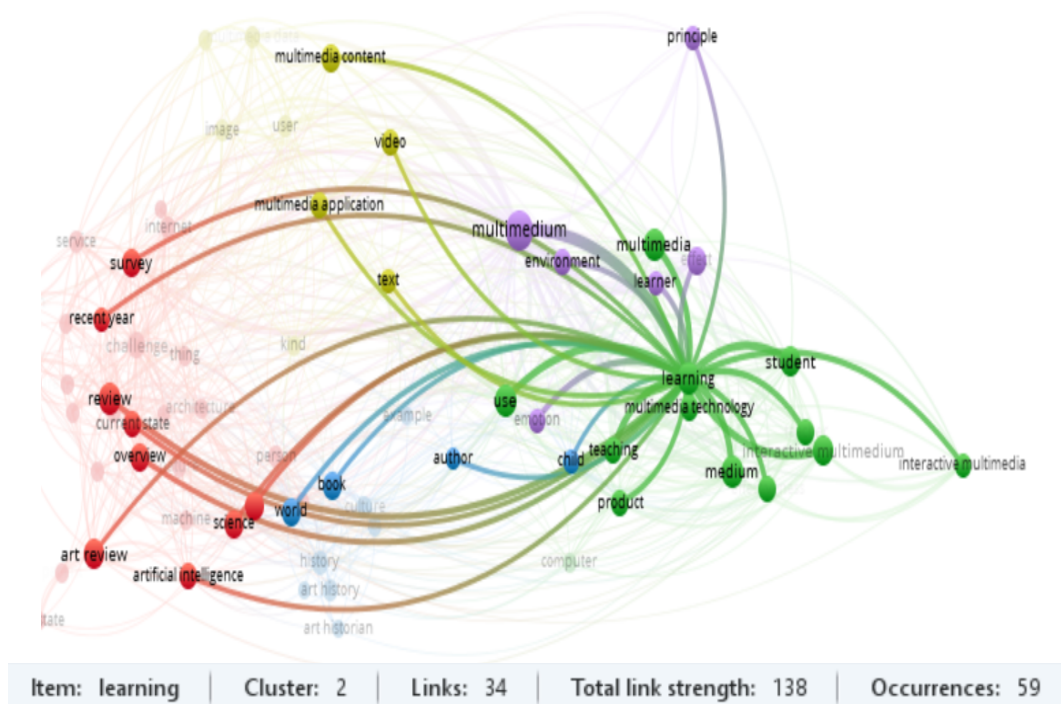i. Students: Learning is closely related to students, as the main purpose of learning is to provide them with experience and knowledge to learn and deepen their understanding of various subjects and fields.

ii. Media: Learning often uses media as a means of communicating information and learning materials to students. Media includes books, audiovisual media, presentations, and digital platforms.

iii. Multimedia is a type of media that presents information and teaching materials interactively by combining various elements such as text, images, sound, and video. Interactive multimedia is the use of multimedia technology to enable active interaction between students and learning content. This may include activities such as answering questions, participating in simulations, or navigating interactive content.

iv. Teacher, the term teacher is related because it has a key role in the learning process. They are responsible for delivering learning materials, providing guidance, and supporting student development.

v. Product, in the context of learning the term product refers to the results or works produced by students as evidence of their understanding of the learning material. This product can be a presentation, term paper, project, or artwork.

vi. Children, learning is often associated with the term child as a participant in education. Its main objective is to facilitate their learning and development in various aspects of life.

vii. The term "author" in relation to the development of learning materials. For example, authors of textbooks, articles, or other sources used in the learning process.

viii. The term "learners" refers to people who actively participate in the learning process. This includes college students, university students, or individuals with a desire to learn and develop their knowledge and skills further.

ix. The term "principle" also relates to learning and encompasses the approach or pedagogy used to design and implement effective learning experiences. This includes principles such as participatory, collaborative, adaptive or student-centred.

x. Multimedia technology is an important concept in learning and can be used as a tool or platform to provide learning materials interactively and effectively. The term multimedia application refers to any software or program designed to present information or learning materials using multimedia elements such as images, video, and audio.

xi. The environment, both physical and digital, can affect student interaction and learning experience. The term "book" is often used as a source of information in learning.

xii. Book. The term has been extensively researched, is relevant to learning, and provides relevant text, images, and illustrative content to support student understanding.

xiii. The world is closely related to learning and can involve our understanding of the world around us, including its social, cultural, geographical and scientific aspects. The term artificial intelligence can be used in learning as a tool or method to improve the experience and effectiveness of learning through intelligent applications and systems.

xiv. Art review refers to the systematic review or evaluation of a particular artwork or art practice, which can be part of the learning process in an art context.

xv.   Surveys can be used in the context of learning to collect data and information from students and other learners as a basis for understanding and developing learning materials.

xvi.   Videos can be used as a powerful learning medium tool to visualize concepts, demonstrate techniques, and illustrate relevant learning situations.

xvii.   Text is a form of written communication that can be used to learn to convey information, explanations, or theoretical content that aids students' comprehension.

xviii.   Used in connection with how media, technology, or learning methods are used in a learning context;

xix.   Science is a branch of science that deals with the study, understanding, and application of knowledge about nature and natural phenomena. Learning science is about exploring and understanding the principles of science.

xx.   The term "review" can refer to a literature review, evaluation, or critical analysis of existing learning materials or learning methods used. The term "summary" refers to an outline or summary of a broad topic of study.

Figure 5 also shows an overlay visualization of a multimedia art learning media study. This overlay of visualization shows the novelty of research on related terms [44,45].

The second word is the media of cluster 2 with the number of links 30, the total link strength 142, and the occurrence of 74 (see Figure 6), and the third term is multimedia from group 2 with a total of 27 links, the total link strength is 110, and event 74, as well as 55 events (see Figure 7).

Fig. 7. Item 2: medium

Figure 8 shows the network of relationships between the term art or art review with other terms, such as industry, art survey, artificial intelligence, survey, challenge, machine, science, people, life, multimedium, art principle, learning, effectiveness, product. Industry: The relationship between art and industry refers to the interaction between art and the industrial world. It involves the use of creativity, design, and artistic expression in an industrial context, such as fine art, graphic design, or other creative industries, can be explained as follows:

i.   An art survey is the systematic research, review, or evaluation of a particular art or art practice. Art surveys can provide insight into trends, preferences, or developments in the context of art.

ii. Survey: A survey in the context of fine art may refer to the collection of data or opinions from respondents to assess preferences, opinions, or responses to a particular artwork or other art topic.

iii. Challenge: Challenge in the arts can refer to situations or contexts that encourage creativity, innovation, or exploration in art practice. These challenges can encourage artists to overcome limitations and create unique work.

iv. Artificial Intelligence: Artificial Intelligence (AI) can be used in art to create interactive artwork or incorporate AI elements in the process of creativity and artistic expression.

v.   Machines: Art can involve the use of machines or technology in the process of creativity and production of works of art. Examples are digital art, kinetic art, or art that uses technology in the process of its creation.

vi. Science: The relationship between art and science involves the exploration or application of the principles of science in the context of art. This could involve the use of technology, material research, or scientific concepts in art practice. People: Art often involves interaction between artists and others, either as spectators, participants, or collaborators in the process of creativity and artistic expression. People become an important part of appreciating and giving meaning to works of art.

vii. Life: Art can reflect and depict aspects of human life, whether in the form of reflecting reality, emotions, experiences, or creative interpretations of life.

viii. Multimedium: Multimedium refers to the use of various media or elements in art, such as the incorporation of images, sound, video, or other elements to create a comprehensive art experience.

ix. Art principles: Art principles include the basic principles used in art, such as composition, shape, colour, texture, etc. Art principles help organize and direct the use of art elements to create balanced and aesthetically pleasing works of art.

x.   Learning: Art can be used as a means of learning and self-development. Learning through art can involve the use of creative expression, observation, reflection, or participation in art experiences to gain deeper insight and understanding.

xi. Effectiveness: Effectiveness in art can refer to the ability of a work of art to communicate a message, inspire, or achieve a desired effect on an audience or viewers.

xii. Product: Product in the context of fine art can refer to the end result of the creative process or production of art, such as a work of fine art, a performance work, a work of music, or any other form of artwork.

Figure 8 also shows that 2019-2020 has the most research conducted on multimedia art learning media. A decrease or decrease in the number of studies from 2021 to 2023 does not mean that there are no new fields to research or new trends to follow. Researchers can identify new trends in multimedia development, learning media, and art learning that may emerge or develop in 2023. This makes it easier to conduct new research on art learning media using multimedia.

These data show that while art, media, multimedia, and learning have been studied extensively, there is no direct relationship between multimedia and learning media, especially art learning. From the mapping results, we can see that art has only 25 links and is associated with 3 terms with related terms in different groups. In contrast to multimedia and learning domains, these domains are closely related and often associated with different terms within clusters. From this, we can conclude that

the field of multimedia art learning media is still studied with high probability and associated with other terms, with a greater impact on the novelty of research.

The third term is multimedia from group 2 with a total of 27 links, a total link strength of 110, and an event of 74, as well as 55 incidents (see Figure 8).
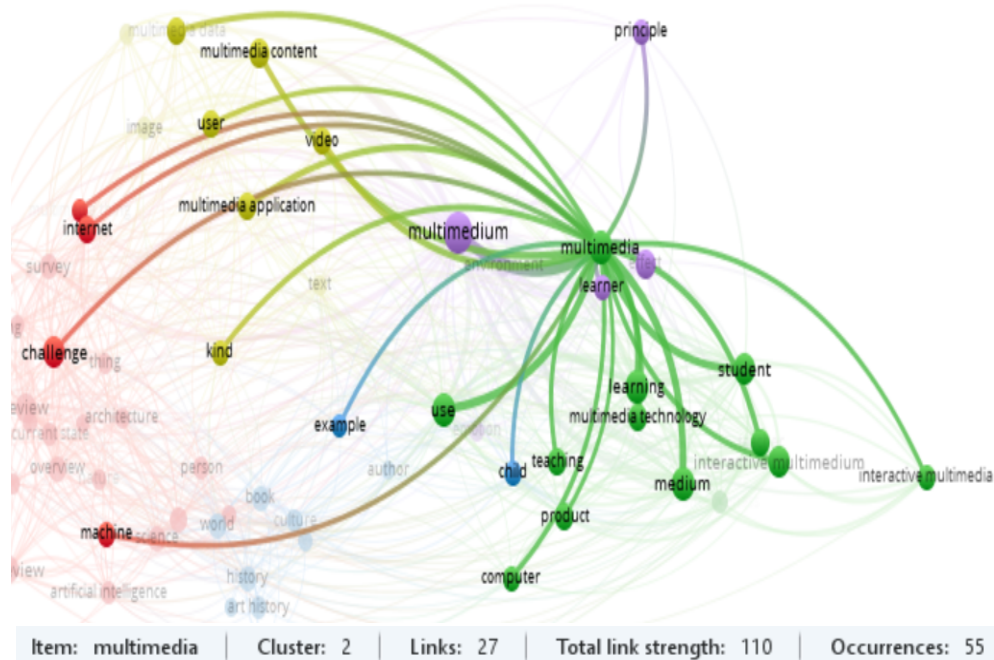

| Item: multimedia | Cluster: 2 | Links: 27 | Total link strength: 110 | Occurrences: 55 |

Fig. 8. Item 3: Multimedia

Figure 9 shows the scope of research related to multimedia art learning media for the 2019-2020 period.

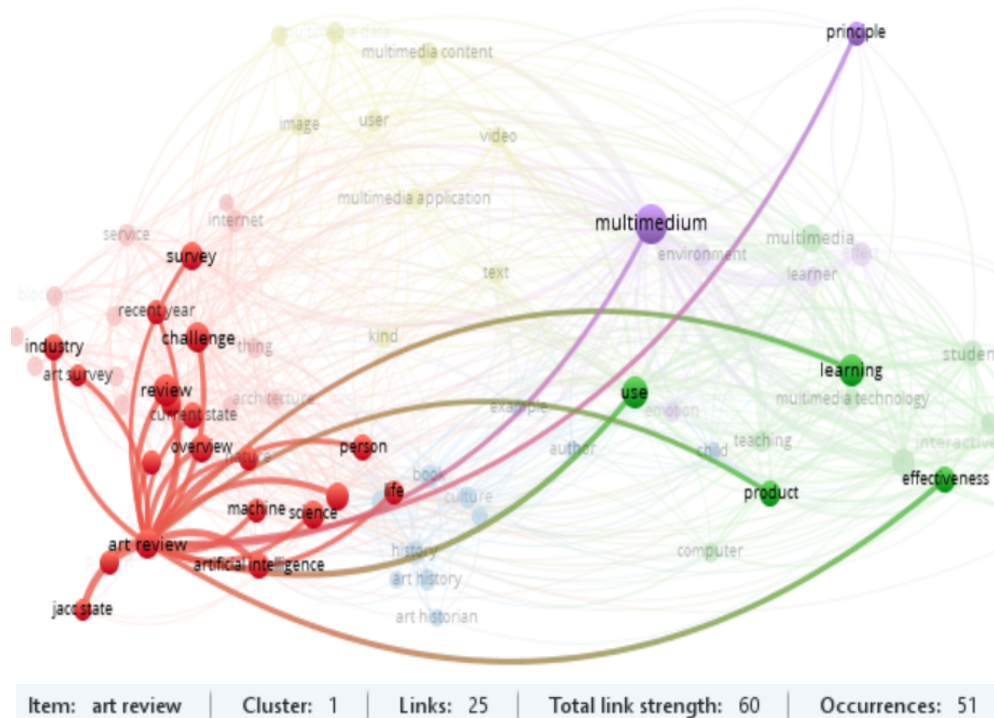| Item: art review | Cluster: 1 | Links: 25 | Total link strength: 60 | Occurrences: 51 |

Fig. 9. Item 4: art (as art review)

Figure 10 shows the scope of research related to multimedia art learning media for the 2019-2020 period.

The fourth term, ART, belongs to group 1 and has 34 linkages, 138 link strengths, and 59 occurrences (see Figure 10).

Fig. 10. Overlay visualization of multimedia art learning media 2019 to 2020

Figure 11, on the other hand, shows the lack of research on this topic in 2021-2023, indicated by the lack of yellow.

Fig. 11. Overlay visualization of multimedia art learning media 2021 to 2023

From the results of this study, we can obtain research on newer and current multimedia art learning media. The rise of multimedia research will significantly relate to the emerging of the fourth Industrial Revolution (IR4.0) [46]. Based on the results of mapping the collected item data, we found that the keywords "multimedia" or "art" or "learning media" were rarely used in the study. Most research papers use only terms and disciplines related to multimedia, art, and learning. From the results of this study, research can be obtained on modern multimedia art learning media.

4. Conclusions

The purpose of this study was to conduct a computational mapping analysis of bibliographic data from research articles. The theme of this research publication is "fine arts learning media utilizing multimedia". The articles used are taken from the Google Scholar database via Publish or Perish. The library data used in this study includes titles and abstracts. Up to 447 affiliate articles were published from search results from 2018 to 2023. The results showed that multimedia art learning media research experienced fluctuations in increase from 2018 to 2020 and decreased from 2021 to 2023. The results showed that research opportunities regarding multimedia art learning media are still very high and related to other terms.

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