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Bibliometric Analysis: Research Trend of Interactive Learning Media in Mathematics Learning in Indonesia

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Abstract

Interactive learning media is a combination of videos, animations, images, and audio on learning media that allows users to interact and understand the material because the learning process becomes interesting, interactive, and effective. The trend of publications that have the highest number of citations, the classification of university or organization rankings, journals and publications, and the use of keywords along with using a database from Google Scholar. The method used is bibliometric analysis. A total of 442 articles were collected from the Publish or Perish (PoP) application using the Google Scholar database which was then combined into 1 file with RIS format and entered into the VOSviewer application to obtain network visualization and visualization overlays. The results show that the trend of publications related to interactive learning media in mathematics education in Indonesia in the last five years (2016 - 2022) has increased every year, the most citations are in the organization "State University of Yogyakarta", in the journal JIPMat, in the article (Istiqlal, 2017). Adobe flash became the most cited learning media keyword. The keywords that became the new theme were Articulate storyline, ispring, discovery learning, interactive games, plane figure, and quadratic functions.

Keywords: Interactive learning media, Bibliometric analysis, Mathematics learning

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INTRODUCTION

Education is a very broad term which that includes the process of gaining general knowledge, self-awareness, and skills to change behavior (Arlinghaus & Johnston, 2018). According to (Gaviria, 2022; Kabwos et al., 2020; Ledger et al., 2021; Lee et al., 2017) education is the right of every child in the world. This is in line with what was expressed by (Somasundaram, 2021) that education is a right for every child wherever he is, whether it is formal or informal education that aims to empower everyone. So, education is a right for every child which includes the process of acquiring knowledge, both formally and informally, that can empower everyone.

At the present time, education has been influenced by society 5.0¸ technology which will encourage changes in the learning process to digital teaching or teaching with learning media, for that a comprehensive education system is needed at all levels of education (Narvaez Rojas et al., 2021). Meanwhile, according to (Rahim et al., 2022) learning media is one element that affects the quality of education, where the selection of the right learning media will achieve good quality education. One element that plays an important role in the success of the learning process is learning media (Azizah et al., 2021; Ediyani et al., 2020;

Harun et al., 2021; Lu'Luilmaknun & Wutsqa, 2019). So, learning media is one of the important elements in education, especially in the learning process.

Learning media is a tool for distributing learning messages and information (Marpanaji et al., 2018; Ramdhani & Muhammadiyah, 2015). Meanwhile, according to (Akbarini et al., 2018; Yusuf & Agung, 2021) learning media is a tool that can attract students' attention in learning that creates a reciprocal relationship between teachers and students. Learning media is a component that is interconnected with other components to achieve the expected learning conditions, and reduce student misunderstandings about the lessons delivered by the teacher (Mayangsari & Mahardhika, 2019; Widodo & Wahyudin, 2018). So, learning media is a tool for distributing learning materials that can attract students' attention during learning. According to (Siregar et al., 2020) for now learning media is very much needed in learning, because in the next few years the number of children who have devices such as computers and androids will increase, these devices will generally be connected to the internet which will be used in learning.

According to (Sahronih et al., 2020) one of the learning media that can be used by students in the era of technology society 5.0 is technology-based media such as interactive learning media, then Sahronih also explains that interactive learning media is a combination of images, animations, videos and sounds in software that must directly or indirectly allow users to interact. Learning must involve interaction between students, teachers, and learning materials with the use of interactive learning media will allow students to learn and understand the material again, students not only focus on learning media but they are required to interact with each other in the learning process (Rahayu et al., 2019). Meanwhile, according to (Suwito et al., 2021) interactive learning media can be learning media that reaches students in terms of cognitive, affective, and psychomotor which make the learning process more interesting, interactive, and effective. interactive learning media can also help students in solve problems and improve learning attitudes and the learning process can be done anywhere and anytime. Furthermore (Wang et al., 2018) revealed that interactive learning media can improve student learning outcomes. So, interactive learning media is a combination of videos, animations, images, and audio on learning media that allows users to interact and understand the material because the learning process becomes interesting, interactive, and effective.

Mathematics generally is one of the core subjects in education in schools (Muhammad & Yolanda, 2022; Sneck et al., 2019). Meanwhile, according to (Barau et al., 2022; Habyarimana et al., 2022) mathematics is a core science in the subject. So, mathematics is a very important science which is one of the core subjects of education. According to (Taofik & Juandi, 2022) mathematics is a subject that must be given to students at every level of education in Indonesia. According to (Putra & Milenia, 2021) mathematics learning is learning where teachers and students work together to take advantage of all existing sources and potentials in mathematics to achieve predetermined mathematics learning goals. Mathematics learning media is a medium that is used for students in delivering mathematics learning material in a real shape to master the use of mathematics, not just rote memorization (Rohaeti et al., 2019). Based on data obtained from Google Scholar using the Publish or Perish (PoP) application, research interest in interactive learning media in the last five years has increased, seen from the number of publications each year, starting from 2016 to 2022 as shown in the figure below.

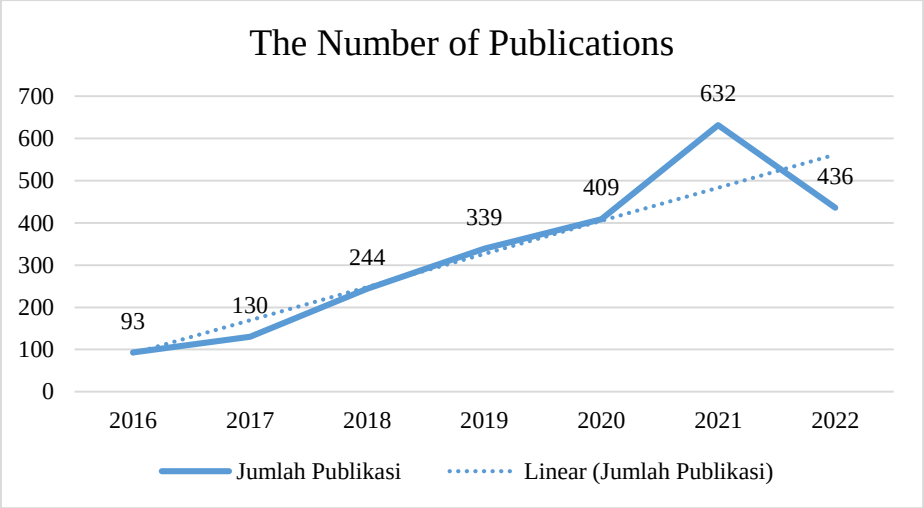


Figure 1. Graph of the increasing number of interactive learning media publications (2016-2022)

Based on Figure 1, can be seen an increase every year, the biggest increase is in 2020 to 2021 with an increase of 55% or an increase of 223 publications. In 2016, research related to learning media only amounted to 93 publications. While 5 years later, in 2022, Research related to interactive learning media increased and totaled 632 publications in 2021. It means that there has been an increase in the number of publications by 580% in 2016-2021. This shows the great research interest in interactive learning media. Therefore, the researchers conducted an analytical study on the results of research related to interactive learning media in mathematics education using bibliometric analysis.

In analyzing a number of publications, a statistical method is needed, one of which is bibliometrics (Muhammad et al., 2022; Phoong et al., 2022). Data analysis carried out in bibliometric research uses quantitative and qualitative indices, such as the author's name, year of publication, and keywords (Zyoud et al., 2017). For searching data sources, researchers obtained data sources from Google Scholar by using the Publish or Perish (PoP) application. According to (Wahab et al., 2021) Google Scholar is a search engine web that can be easily used to index full text or metadata of academic literature across a series of publications. Meanwhile, Publish or Perish (PoP) is a software program that retrieves and analyzes academic citations using various data sources (Hudha et al., 2020). Researchers took and analyzed information from the Google Scholar database and used evaluative and descriptive bibliographic analysis.

The study related to this research is research conducted by (Widyaningrum et al., 2022) which is about the study of learning media literature in elementary schools, the results of this study indicate that research trends that discuss learning media include media development, STEM-based learning, 21st-century, learning media applications, animated videos, games, software, and mobile learning, the research suggests that further research should look for other keywords such as interactive learning media. Furthermore, research conducted by (Subagja, 2022) on the analysis of update mapping in learning media research, the results show that the words that are often discussed in learning media are web, media, android, skills, and STEM, the study suggests that further research expands the keywords used. From the results of the study, the researchers expanded the keyword into interactive learning media, especially in mathematics education in Indonesia. Based on the related research above, previous researchers only discussed learning media, not specifically discussing interactive learning media, especially in mathematics education, in research conducted by Widyaningrum also only discussed learning media at certain educational level, namely elementary schools. Therefore, researchers conducted an analysis of research related to interactive learning media in learning mathematics using bibliometric analysis. This study

aims to identify publications on interactive learning media in mathematics education and describe the characteristics of the research.

METHOD

In this study, the results of published research related to interactive learning media in mathematics education included in the Google Scholar database in the last 5 years, (2016-2022), were analyzed using bibliometric analysis methods and bibliometric visualization using an evaluative and descriptive approach. This study used VOSviewer for visualizing and evaluating all information about publications that have been collected, such as; author name, year of publication, and keyword. VOSviewer is software for creating network visualizations of terms commonly used in certain fields (Oyewola & Dada, 2022).

According to (Dewi et al., 2021) there are five stages of research in bibliometric analysis, the five stages can be seen in the picture below as follows.

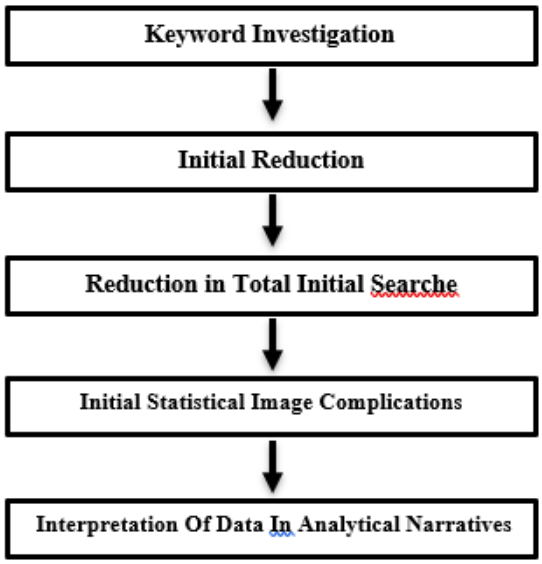


Figure 2. Stages of bibliometric analysis

In the Figure 1 above, there are five stages in bibliometric analysis, namely, 1) keyword investigation; researchers set the keywords " interactive learning media"; 2) initial reduction: after we define the keywords in stage one, then we do a search for those keywords with the google scholar database using the PoP application; 3) reduction in total initial searches; in this third stage the researcher determines the limits according to the needs in the VOSviewer application to select related publications that have been obtained in the previous stage; 4) initial statistical image complications: at this stage, the researcher groups the data as topic descriptions such as bibliographic pairs of institutions, journals, documents, and occurrences with the author's keywords: 5) interpretation of data in analytical narratives: at the last stage the researcher interprets data from visualizations has been obtained with VOSviewer which can then be developed by researchers.

Data collection used Publish and Perish (PoP) on September 12, 2022. Data was gotten from the Google Scholar database through PoP with the keyword “interactive learning media” and “mathematics” publication name was “journal” and the year of publication article was “2016-2022”. Researchers use the Google Scholar database because Google Scholar is a web search engine that can easily be used to index full text or academic literature metadata across a series of publications (Wahab et al., 2021). Based on the results of searching data using PoP, at first, the researcher found 2283 articles related to interactive learning media, but when the researcher focused on the keywords "interactive learning media" and "mathematics learning" and adjusted to the research criteria, namely articles published only in journals and several from the book review, only 442 articles remained, then the 442

articles were used as research samples with research criteria . Data is saved as RIS/RefManager to use in VOSviewer software. VOSviewer is used to do mapping in finding scientific publication trends in Indonesia using the Google Scholar database related to interactive learning media in mathematics education based on bibliographic pairs of organizations, journals, authors, and keywords.

RESULTS AND DISCUSSION

In presenting the results of bibliometric analysis, this study refers to (Donthu et al., 2021; Ellili, 2022) starting from the number of citations, countries, organizations, journals, authors, and keywords. This study was only conducted in Indonesia, then researchers start from the number of citations, organizations, journals, authors, and keywords that were visualized by VOSviewer, such as; Network Visualization, and Overlay Visualization (Muhammad et al., 2023).

Initially, there were 2283 publications in the Google Scholar database related to interactive learning media. However, the researchers narrowed down the keywords into interactive learning media in mathematics education in Indonesia, then publications in the Google Scholar database became 442 publications shown in the table below.

Table 1. The number and percentage of publications related to interactive learning media in Mathematics Education in Indonesia (2016-2022)

No	Year publications	Number of publications	Percentage (%)
1	2022	94	21.27
2	2021	90	20.36
3	2010	66	14.93
4	2019	75	16.97
5	2018	53	11.99
6	2017	50	11.31
7	2016	14	3.17
	Total	442	100.00

Based on Table 1, 2022 becomes the highest number of publications, with 94 publications or 21,27%. There was an increase in the number of publications from 2016, only 14 publications, to 2022, with 94 publications. Of the 442 publications, most came from articles or journals, and some from book reviews. Articles in the Google Scholar database are often used as references or citations in other studies, which means the more citations from articles, the more articles widely used as references in other studies (Supinah & Soebagyo, 2022). Therefore, researchers use the number of citations in sorting the organizations, journals, and authors.

Table 2. The most citations of university related to interactive learning media in Mathematics Education in Indonesia

No	University	Number of citations	Number of publications
1	State University of Yogyakarta	29	11
2	Jambi University	27	3
3	PGRI Semarang University	18	5
4	Lampung University	17	1
5	Ahmad Dahlan Universitas	17	6
6	Raden Intan State Islamic University	17	1
7	State University of Malang	16	9
8	Sunan Gunung Djati State Islamic University	16	1
9	Syiah Kuala University	13	1

No	University	Number of citations	Number of publications
10	Padang State University	11	7

Based on Table 2, the State University of Yogyakarta becomes a university that has the most citation in the publications of interactive learning media, with 29 citations and 11 publications. Jambi University has 27 citations and 3 publications. Of the top 10 universities, 5 universities came from Java Island, State University of Yogyakarta, PGRI Semarang University, Ahmad Dahlan University, State University of Malang, and Sunan Gunung Djati State Islamic University. While the other 5 universities came from Sumatra Island, Jambi University, Lampung University, Raden Intan State Islamic University, Syiah Kuala University, and Padang State University. This indicates that the study of interactive learning media is not evenly distributed in Indonesia, the study with the highest number of citations only came from 2 islands, Java and Sumatra. This means that the study of interactive learning media in other big islands such as; Kalimantan, Sulawesi, and Papua, is still low.

The 10 journals with the highest number of citations, that have the Google Scholar index related to interactive learning media in the national and international journals, were presented in Table 3.

Table 3. The highest number of journal citations related to interactive learning media in Mathematics Education in Indonesia

No	Journal Name	Number of citations	Number of publicataions
1	JIPMat (Jurnal Ilmiah Pendidikan Matematika)	35	1
2	Jurnal Pendidikan Matematika	19	3
3	Eduhumaniora: Jurnal Pendidikan Dasar	17	1
4	Scholaria: Jurnal Pendidikan Dan Kebudayaan	17	2
5	Jurnal Inovasi Teknologi Pendidikan	16	4
6	Jurnal Cendekia: Jurnal Pendidikan Matematika	13	16
7	JNPM (Jurnal Nasional Pendidikan Matematika)	10	2
8	Beta: Jurnal Tadris Matematika	10	1
9	Wacana Akademika: Majalah Ilmiah Kependidikan	8	1
10	Jurnal Pendidikan Matematika (Kudus)	7	4

Based on Table 3, JIPMat becomes a journal that has the most citations in the publications of interactive learning media, with 35 citations and 1 publication. Jurnal Pendidikan Matematika has 19 citations and 3 publications. Of the top 10 journals, 5 journals indexed Sinta 3, Eduhumaniora: Jurnal Pendidikan Dasar, Scholaria: Jurnal Pendidikan dan Kebudayaan, Jurnal Inovasi Teknologi Pendidikan, Jurnal Cendekia: Jurnal Pendidikan Matematika, and JNPM (Jurnal Nasional Pendidikan Matematika. 3 journals indexed Sinta 4, JIPMat (Jurnal Ilmiah Pendidikan Matematika), Wacana Akademika: Majalah Ilmiah Kependidikan, Jurnal Pendidikan Matematika (Kudus), and 2 journals indexed Sinta 2, Jurnal Pendidikan Matematika dan Beta: Jurnal Tadris Matematika. It means that the publication results of interactive learning media are related to the focus and scope of the above journals.

Publications indexed the Google Scholar related to interactive learning media for Mathematics Education in journals with more than 10 citations are presented in Table 4

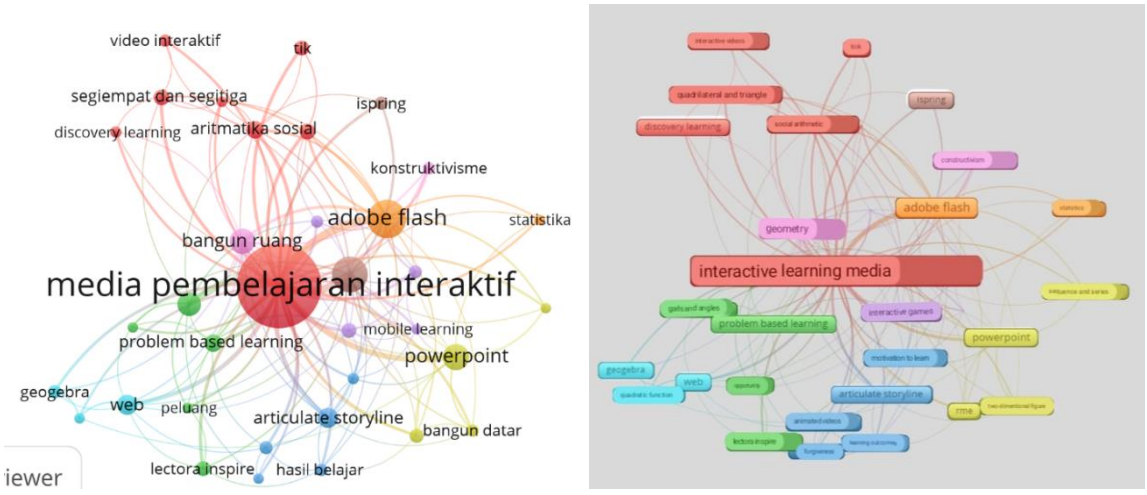
Table 4. The most publication citations in interactive learning media in Mathematics Education in Indonesia

No	Author	Article Title	Year	Journal Name	Citations
1	Istiqlal	Interactive Multimedia Development in Mathematics Learning	2017	Jipmat (Jurnal Ilmiah Pendidikan	35

No	Author	Article Title	Year	Journal Name	Citations
				Matematika)	
2	Batubara	The use of Video as a Medium for Mathematics Learning in Elementary School	2016	Muallimuna: Jurnal Madrasah Ibtidaiyah	19
3	Widjayanti	Animation-based Interactive Learning Media on Statistics Material for 7th Grade Junior High School Students	2018	Jurnal Pendidikan Matematika	17
4	Hakim	The Effect of Using Interactive Multimedia in Mathematics Learning to Improve Elementary School Students' Learning Outcomes	2016	EduHumaniora: Jurnal Pendidikan Dasar	17
5	Irawan	The Implications of Flash-based Interactive Multimedia on Motivation and Achievement in Mathematics Learning	2017	Beta: Jurnal Tadris Matematika	10

Based on Table 4, the article the title "Interactive Multimedia Development in Mathematics Learning" written by (Istiqlal, 2017) has 35 citations, and an article titled "The Use of Video as a Medium for Mathematics Learning in Elementary School" written by (Batubara & Ariani, 2016) has 19 citations, the articles with the highest citations respectively are articles written by (Widjayanti et al., 2018), (Hakim & Windayana, 2016), and (Irawan & Suryo, 2017). The articles above can be used as references for further studies related to interactive learning media in mathematics learning.

The data obtained from the PoP software was combined with the RIS format in one file, and then the file was entered into the VOSviewer software to get the results of the bibliometric analysis. Researchers use a threshold in determining the use of shared keywords, at least five keywords together. It means that one keyword was used in at least five different articles that appear in the visualization on VOSviewer. The visualization is shown in the picture below.



(a) in Indonesian (b) in English

Figure 3. Network visualization of the keyword occurrence

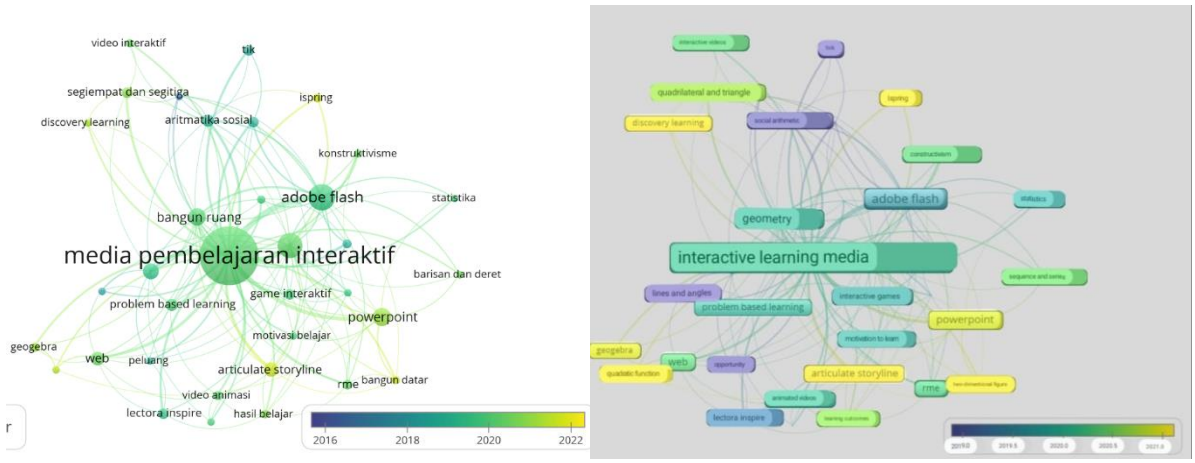
Based on Figure 2 shows that "interactive learning media" became the most frequently found keyword, with 304 shared keyword usage. It can be seen by the size of the circle in the keyword "Interactive Learning Media". The bigger the circle, the more researchers use this keyword related to interactive learning media in mathematics education in Indonesia. For more details regarding the use of shared keywords can be seen in the following Table 5.

Table 5. The most common keyword occurrences related to interactive learning media in mathematics education in Indonesia

No	Keyword	Occurrence
1	Interactive Learning Media	304
2	*Adobe Flash*	64
3	*Android*	55
4	*Powerpoint*	30
5	Geometry	28
6	*Macromedia Flash*	24
7	*Articulate Storyline*	18
8	*Web*	17
9	Social Arithmatic	13
10	*Problem Based Learning*	13
11	Lingkaran	11
12	Quad and Triangle	11
13	Interactive Games	10
14	*Lectora Inspire*	10
15	ICT	10

Based on Table 5 shows that many researchers are interested in Adobe Flash, proven by shared keyword usage that appears in as many as 64 articles. Android keyword appears with 55 shared usages, and the Powerpoint keyword appears with 30 share usage. Other media that are also included in the most common occurrences are Macromedia Flash, Articulate Storyline, and Lectora Inspire. The mathematics learning materials that have the most co-occurrence are spatial, social arithmetic, circles, quadrilaterals and triangles. There are other keywords such as; Web, Problem Based Learning, and Technology & Information. This means the Adobe Flash keyword was used as a medium for learning, and Geometry was a learning material. These are the most widely used research on interactive learning media in mathematics learning in Indonesia.

Network visualized result in Figure 2 shows that there are 9 clusters with 35 items related to interactive learning media in mathematics education in Indonesia, namely: 1) cluster 1 (red) consists of eight items (social arithmetic, discovery learning, circle, interactive learning media, contextual approach, rectangular and triangle, tik, and interactive video); 2) cluster 2 (green) consists of five items (line and angle, lectora inspire, macromedia flash, probability, and problem based learning); 3) cluster 3 (dark blue) consists of five items (articulate storyline, learning outcomes, set, learning motivation, and animation video); 4) cluster 4 (yellow) consists of four items (plane figure, sequence and series, powerpoint, and realistic mathematics education); 5) cluster 5 (purple) consists of four items (interactive game, mobile learning, concept understanding, and trigonometry); 6) cluster 6 (light blue) consists of three items (quadratic function, geogebra, and web); 7) cluster 7 (orange) consists of two items (adobeflash and statistic); 8) cluster 8 (brown) consists of geometry and contructivism; and 9) cluster 9 (pink) consists of geometry and contructivism.



(a) in Indonesian (b) in English

Figure 4. Overlay visualization of the occurrence of keywords together based on the year of publication

Based on Figure 3, there are three different colours. The yellow colour indicates that the keywords will be used together around 2022. Blue colour indicates the keywords used together around 2016, and green colour indicates the keywords used around 2018-2022. This shows there is a change in terms over a certain period of time. Keywords that become a new theme are Articulate story, ispring, discovery learning, interactive game, plane figure, and quadratic function. Meanwhile, keywords that become the old theme are TIK and contextual approach. It means there is a change from TIK (information technology and communication) to learning using media, such as Articulate storyline and ispring. Then there is also a change from a contextual approach to discovery learning.

To see the relationship between one keyword and another can be seen from the link given. Based on Figure 2, it can be seen that the Adobe Flash keyword, the most cited keyword, does not directly involve problem-based learning and discovery learning. Then there is a solid figure that does not directly involve interactive video and Lectora inspire. The latest theme, such as the Articulate storyline, is not directly related to the quadratic function material, which is also the latest material. From these relationships, this is a gap that can be useful for further research related to interactive learning media in mathematics education in Indonesia.

Based on the discussion above, research or the number of publications related to interactive learning media in mathematics education in Indonesia increases every year. The highest number of citations in the university is from the State University of Yogyakarta, with 29 citations. In the journal is JIPMat (Jurnal Ilmiah Pendidikan Matematika) with 35 citations, and in the article is the article written by Istiqlal, "Interactive Multimedia Development in Mathematics Learning". Adobe Flash keyword became the most cited learning media keyword, with 64 citations. Keywords that become new themes are Articulate storyline, ispring, discovery learning, interactive game, plane figure, and quadratic function. Adobe Flash keyword does not directly involve problem-based learning and discovery learning. The solid figure does not directly involve interactive video, and Lectora inspires. An articulate storyline also does not directly involve quadratic functions. This is a gap that can be useful for further research related to interactive learning media in mathematics education in Indonesia.

CONCLUSION

The publication trend in journals indexed by Google Scholar related to interactive learning media in mathematics education in Indonesia during five years (2016-2022) increases every year. The university with the most citations is the State University of Yogyakarta, with 29 citations. The journal with the most citations, 35 citations, is JIPMat

(Jurnal Ilmiah Pendidikan Matematika). Article "Interactive Multimedia Development in Mathematics Learning" written by Istiqlal (2017) has the most citations, 35 citations. Adobe Flash became the most cited keyword of learning media, with 64 citations. Keywords that become new themes in mathematics education are Articulate Storyline, Ispring, discovery learning, game interactive, plane figure, and quadratic function. Adobe Flash keyword does not directly involve problem-based learning and discovery learning. The solid figure does not directly involve interactive video, and Lectora inspires. An articulate storyline also does not directly involve quadratic functions. This is a gap that can be useful for further research related to interactive learning media in mathematics education in Indonesia.

RECOMMENDATION

We suggest that the next researchers expand the keywords that will be used on the research topic. Researchers can use Scopus and WoS (Web of Science) for searching and collecting data.

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