Top 100 Cited Publications for The Last Thirty Years in Digital Learning and Mobile Learning

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Abstract—Digital learning and mobile learning are two different things but have something in common. This research aims to find trends, topics, similarities, differences, advantages, and disadvantages of digital learning and mobile learning over the last thirty years (1992 – 2021). The method used in this research is bibliometric analysis with the help of Ms-excel, VOSViewer, and Wordcloud to visualize the metadata obtained from Scopus. The findings show that the trend of digital learning continues to increase from year to year. In addition, it can explain that mobile learning is an innovative part of digital learning with almost the same differences, similarities, advantages, and disadvantages. In the future, it is hoped that further research related to digital learning will continue to develop along with technological developments.

Keywords—Bibliometric, digital learning, mobile learning, VOSViewer

1 Introduction

Education is so important for humans because it is one of the paths to success regardless of origin. This is evidenced by learning and development of knowledge from time to time continues to grow [1][2]. This is compounded by the existence of new policies that continue to change from year to year. There are so many changes that occur in the world of education [3][4]. According to [5][6], education is very important to continue to be developed in order to provide learning opportunities for all groups. In addition, education is included in the world leader's action plan known as the SDGs (Sustainable Development Goals) [7][8]. Major changes occurred during the Covid-19 pandemic. This causes learning to switch from offline (direct) to online (virtual) [9][10]. That way, new innovations and terms have emerged, such as learning platforms, learning applications, digital learning, online learning, web learning, e-modules, e-books, and many more. Several studies have been conducted regarding online learning models including mobile learning, the effectiveness of digital technology, digital readiness, digital comics, and usability of mobile learning apps [11][12][13][14][15].

Digital learning and mobile learning are the main topics of discussion in the world of education today [16][17]. This will certainly continue to grow along with technological developments. However, it is necessary to know about these developments through

research that has been carried out by various authors and institutions by looking at the publications of previous studies to date in the form of conference proceedings, journal articles and other scientific media [18][19]. According to Yeaung et.al [20] , to see the most impactful topics is not easy to access. Therefore, there is a need for bibliometric analysis to identify and explore impactful topics [14][21]. Using bibliometric analysis can provide a valid review quality, visualize salient areas, improve understanding of the distribution of a research topic, and provide clues for future research [22][23][24]. In addition, bibliometric analysis is assisted by using the VOSViewer, MS-Excel, and Word cloud software in visualizing the research results to make it more interesting.

The purpose of this study is to conduct a literature review related to digital learning and mobile learning topics for one hundred cited in the last thirty years from 1992 to 2021 using bibliometric analysis.

2 Methodology

This research is a type of quantitative research based on the Scopus database. Then, using bibliometric analysis that can prove and find novelty and trends in research [25][26][27][28]. Data collection was obtained through a Scopus search as of 23 January 2022 with the following criteria;

Table 1. Screening data

Description	**Digital Learning**	**Mobile Learning**
Keywords	Title (digital AND earning)	Title (mobile AND learning)
Document All Year	6255 Document	9542 document
Document year (1992-2021)	6148 Document	9481 document

Then the metadata is saved in csv format. and risk. After that, further analysis was carried out using software such as MS-Excel, VOSViewer, and WordCloud to make the data display more attractive [25][29][30]. According to Putri et al. [21] the effectiveness of VOSViewer has been proven in a recent study that has been carried out with the Scopus index.

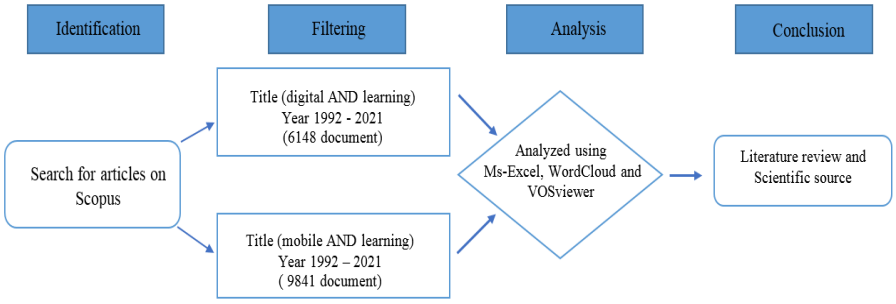
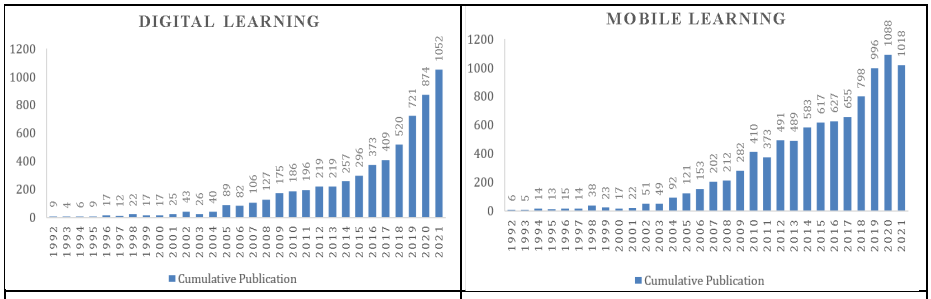


Figure 1. Flowchart research

3 Result and Discussion

3.1 Publication research trend

Figures 1a and 1b show a very significant development in the publication of articles on Scopus over the last thirty years. This shows that the high interest of the academic community towards research and the trends that are developing are very high.



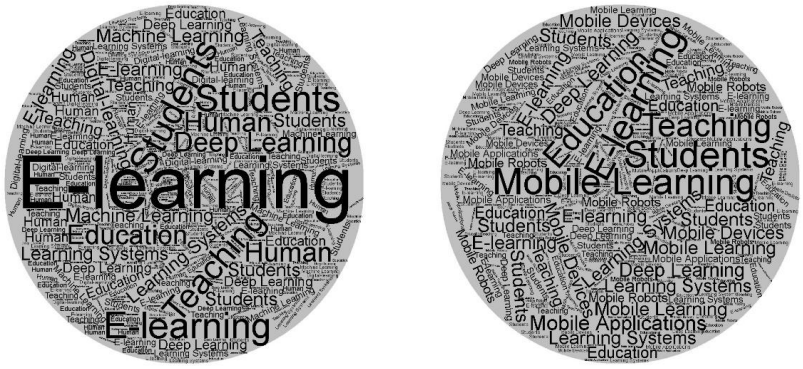
(a) Digital learning (b) Mobile learning

Figure 2. Publication trend digital learning and mobile learning last thirty years

Figure 2 shows the number of articles in the field of digital learning and mobile learning at Scopus.

3.2 Visualization keyword of papers

The most frequently used keywords are graphically shown in Figure 3. Larger font sizes represent the frequency with which words are used the most. Words that are commonly used in digital learning are E-learning, students, human, teach, deep learning, etc. As for mobile learning, the words that are often used are mobile learning, students, E-learning, teaching, mobile application, education, etc.



(a) Digital Learning (b) Mobile Learning

Figure 3. The most relevant keywords

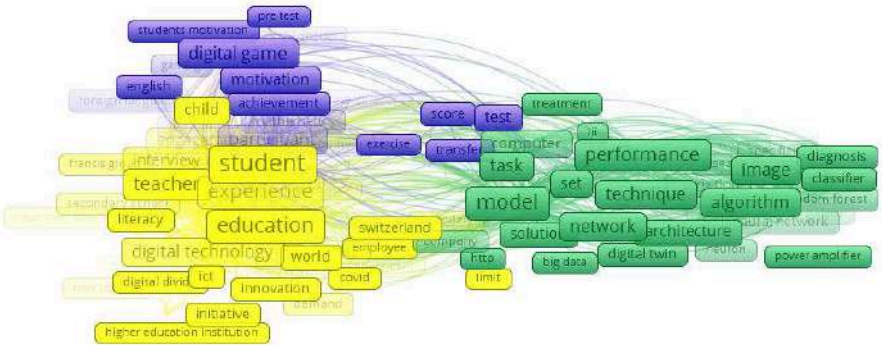


Figure 3a. The network visualization relevance trend in digital learning

Based on Figure 4(a) the relevance trend in digital learning produces three visible color clusters (yellow, green, and purple).

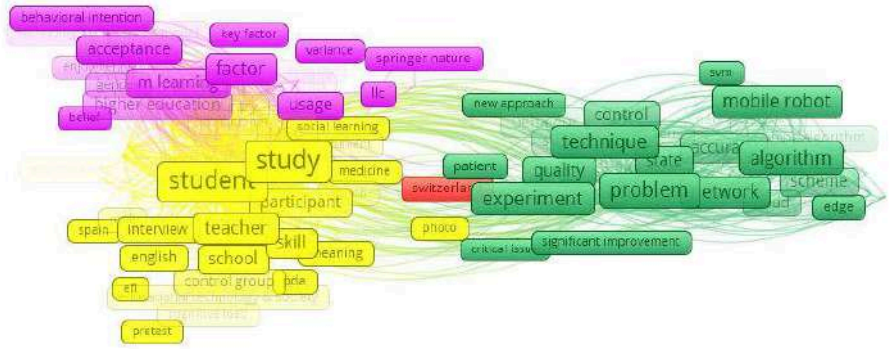


Figure 4b. The network visualization relevance trend in mobile learning

Based on Figure 4(b) the relevance trend in digital learning resulted in four visible color clusters (yellow, green, purple, and red).

3.3 Publication Type

Table 2. Document type of top cited paper

Document Type	Frequency		Total Cited		Mean		Median		SD	
	DL	ML	DL	ML	DL	ML	DL	ML	DL	ML
Article	80	82	13544*	21680*	169.3	264.4	119.0	212.5	158.8	132.8
Conference Paper	8	11	872	2637	109.0	239.7	92.0	229.0	45.9	65.7
Book	6	2	905	666	150.5	333.0	129.0	333.0	61.8	79.2
Review	4	4	758	1363	189.0*	340.8*	204.0*	339.5*	95.7	103.2

Book Chapter	1	1	88	299	88.0	299.0	88.0	299.0		-
Editorial	1	-	363	-	363.0	-	363.0	-	-	-
Total	**100**	**100**	**16530**	**26647**	**1069.6**	**1477.9**	**-**	**-**	**-**	**-**
*=the highest number										

Document types from the top 100 papers published in digital learning and mobile learning from 1992 to 2021 can be seen in Table 2.

3.4 Distribution of Top Cited 100 Paper

Table 2. Distribution paper

Digital Learning						Mobile Learning					
Year	**Paper**	**Citation**	**ACPP**	**HAPPY**	**City Year**	**Year**	**Paper**	**Citation**	**ACPP**	**HAPPY**	**Citable**
1992	1	95	95.0	3.2	30	1995	1	202	202.0	7.5	27
1995	2	215	107.5	4.0	27	1996	1	222	222.0	8.5	26
2001	2	414	207.0	9.9	21	1998	2	903	451.5	18.8	24
2004	2	450	225.0	12.5	18	2000	1	601	601.0*	27.3	22
2005	4	1219	304.8	17.9	17	2002	4	872	218.0	10.9	20
2006	2	261	130.5	8.2	16	2003	6	1368	228.0	12.0	19
2007	5	878	175.6	11.7	15	2004	2	471	235.5	13.1	18
2008	5	844	168.8	12.1	14	2005	2	614	307.0	18.1	17
2009	7	2253	321.9*	24.8	13	2006	1	160	160.0	10.0	16
2010	3	410	136.7	11.4	12	2007	8	2170	271.3	18.1	15
2011	7	904	129.1	11.7	11	2008	6	2364	394.0	28.1	14
2012	10	1298	129.8	13.0	10	2009	10*	2856*	285.6	22.0	13
2013	7	1159	165.6	18.4	9	2010	8	1923	240.4	20.0	12
2014	8	860	107.5	13.4	8	2011	7	2328	332.6	30.2	11
2015	4	420	105.0	15.0	7	2012	5	1870	374.0	37.4	10
2016	11*	2433*	221.2	36.9	6	2013	5	1445	289.0	32.1	9
2017	4	5 33	133.3	26.7	5	2014	5	986	197.2	24.7	8
2018	6	807	134.5	33.6	4	2015	2	390	195.0	27.9	7
2019	8	711	88.9	29.6	3	2016	8	2211	276.4	46.1	6
2020	2	274	137.0	68.5*	2	2017	7	1510	215.7	43.1	5
-	-	-	-	-	-	2018	4	774	193.5	48.4	4
-	-	-	-	-	-	2019	4	1181	295.3	98.4*	3
-	-	-	-	-	-	2020	1	225	225.0	112.5	2
Total	100	16438	3224.5	382.3		Total	100	27646	6409.8	715.2	
ACPP= Average Citation Per Paper , ACPPY= Average Citation Per Paper Per Year, *= the highest number											

Based on the Table 2 above, for digital learning and mobile learning, publications do not occur every year.

3.5 Top 10 Authors with more articles

Table 3. Top 10 author with more article

Digital Learning			Mobile Learning		
Author	**Document**	**Country**	**Author**	**Document**	**Country**
Ifenthaler, D	15	Curtin University (Australia)	Hwang, GJ	70	National Taiwan University of Science and Technology (Taiwan)

Digital Learning			Mobile Learning		
Author	**Document**	**Country**	**Author**	**Document**	**Country**
Lam, EY	14	The University of Hong Kong (Hong Kong)	Huang, YM	39	National Cheng Kung University (Taiwan)
Chen, GD	13	National Central University(Taiwan)	Milrad, M	36	Linnaeus University (Sweden)
Barber, W.	12	Ontario Tech University (Canada)	Kukulska-Hulme, A	34	The Open University, Milton Keynes (United Kingdom)
Hwang, GJ	12	National Taiwan University of Science and Technology (Taiwan)	Wong, LH	34	National Institute of Education (Singapore)
Bandung, Y	11	Bandung Institute of Technology (Indonesia)	Traxler, J	30	University of Wolverhampton (United Kingdom)
Lee, JS	11	The Education University of Hong Kong (Hong Kong)	Looi, CK	29	Center for Research and Development in Learning (Singapore)
Erstad, O	9	Universitetet I Oslo (Norway)	Parsons, D	26	The Mind Lab, Auckland (New Zealand)
Huang, YM	9	National Cheng Kung University (Taiwan)	Sharples, M	26	The Open University, Milton Keynes (United Kingdom)
Sampson, DG	9	University of Piraeus (Greece)	Specht, M	24	Delft University of Technology (Netherlands)

Table 3 shows the top 10 authors' articles with the highest number of documents from 1992 to 2021 from different countries.

3.6 Top Country of Publication 100 Highest

Table 4. Top countries 100 cited publication (1992-2021)

Digital Learning				Mobile Learning			
Country	**Article**	**Total Citation**	**Average Article Citation**	**Country**	**Article**	**Total Citation**	**Average Article Citation**
United States	33	6452	195.52	Taiwan	26	8308	319.54
United Kingdom	13	2120	163.08	United States	19	5658	297.79
Taiwan	7	584	83.43	United Kingdom	17	3166	186.24
China	5	435	87.00	Singapore	4	879	219.75
Netherlands	5	1532	306.40	South Korea	3	744	248.00
Australia	4	490	122.50	Switzerland	3	831	277.00
Belgium	4	423	105.75	Australia	3	646	215.33
Finland	4	598	149.50	China	3	626	208.67
Hong Kong	4	548	137.00	Japan	3	622	207.33
Canada	3	1187	395.67	Netherlands	2	373	186.50
Germany	3	475	158.33	Germany	2	400	200.00
South Korea	3	510	170.00	Italy	2	382	191.00

Digital Learning				Mobile Learning			
Country	**Article**	**Total Citation**	**Average Article Citation**	**Country**	**Article**	**Total Citation**	**Average Article Citation**
France	1	295	295.00	Turkey	2	353	176.50
Greece	1	984	984.00	Canada	2	400	200.00
Italy	1	74	74.00	South Africa	1	303	303.00
New Zealand	1	137	137.00	Nigeria	1	300	300.00
Norway	1	81	81.00	Hong Kong	1	285	285.00
Oman	1	292	292.00	Malaysia	1	213	213.00
Russian	1	77	77.00	Spain	1	196	196.00
Singapore	1	189	189.00	Portugal	1	180	180.00
Spain	1	305	305.00	Chile	1	170	170.00
Switzerland	1	105	105.00	Finland	1	163	163.00
Thailand	1	74	74.00	France	1	162	162.00
Turkey	1	71	71.00	-	-	-	-
Total	100	18038	4758.2	**Total**	**100**	**25277**	**5061.3**

The calculation of the publication of articles from countries is only based on the affiliation that published the articles. Table 4 shows that there are country differences between the top 100 digital learning papers and the top 100 mobile learning papers.

3.7 Top 10 Productive Countries

When analyzing we found the leading countries that have the most publications on digital learning and mobile learning. Each of the top three countries that have the most publications during 1991 to 2021 are the United States (1354 doc), United Kingdom (456 doc), and China (407 doc) for digital learning which can be seen in Figure 5a. As for mobile learning, the top three countries that have the most publications during 1991 to 2021 are China (1390 docs), United States (1359 docs), and United Kingdom (659 docs) which can be seen in Figure 5b.

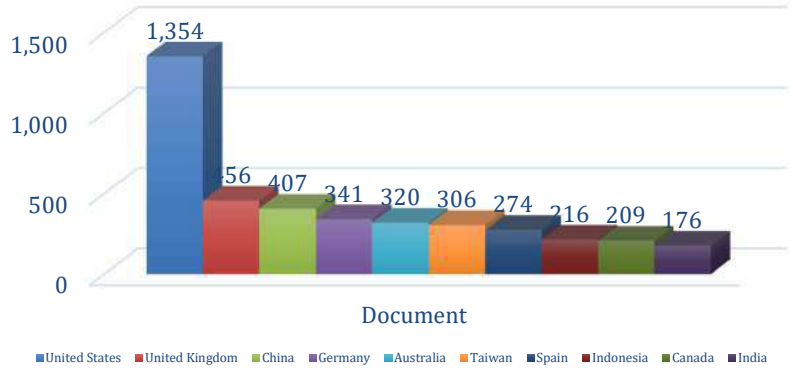


Figure 5a. Top 10 productive countries digital learning

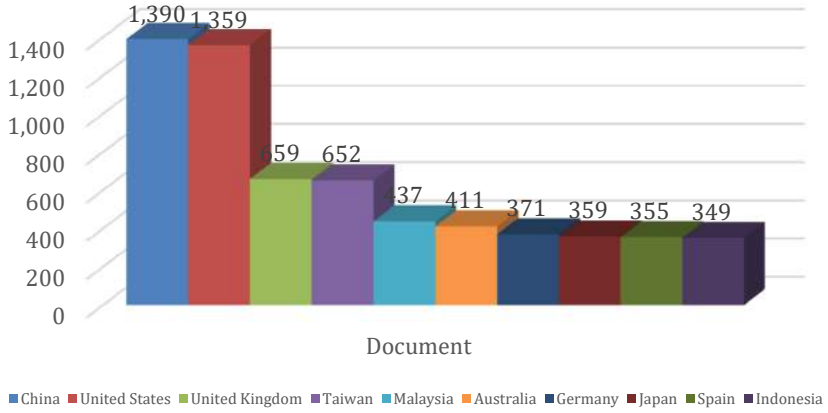


Figure 5b. Top 10 productive countries mobile learning

3.8 The differences and similarities between digital learning and mobile learning

After reviewing literature and other scientific sources, facts are obtained which state that there are so many differences and similarities between digital learning and mobile learning. That way, it is important to discuss this so that it can reduce misconceptions about digital learning and mobile learning. For more details presented in table.5

Table 5. Differences and similarities digital learning and mobile learning

Description	Digital Learning	Mobile Learning
Understanding	Digital learning is a digital learning resource that includes many elements to be used in learning [32]	Mobile learning is a learning model that adopts the development of mobile technology and mobile devices (HP) as a learning medium[33]
Function	Facilitates the learning process and presents more interesting teaching materials [32]	As an alternative to mobile or mobile-based learning services[34]
Forms/types of	• Blended learning • Online Learning/E-learning • Use of technology (applications, google, and the like) • Adaptive learning	• Applications • Web
Existence	continues to grow	Continuously develops

Description	Digital Learning	Mobile Learning
Devices	HP, notebook, Tablet, PDA, Computer, Web, PC, Tv, CD-ROM, and etc	Mobile, notebook, tablet, smartphone and PDAs.
Features	Video Streaming/live, virtual whiteboards, quizzes/virtual exams, discussion threads, online questionnaires, online TV, and etc [35]	Features that can be used Based on the type of application installed [36]
Scope	Covers all bases digital	According to the specs of the device used
Approach	All media	Certain applications
Size	Flexible	According to device
Application	All applications	Limited applications
Place	Virtual Classroom online, teachers in class, and internet labs	Flexible learning (anywhere and anytime)
Access	Internet	Internet

Based on Table 5 shows the differences and similarities between digital learning and mobile learning.

Figure 6. relationship illustration digital learning and mobile learning

3.9 The advantages and disadvantages of digital learning and mobile learning

The results of the study of literature and scientific sources related to the topic of digital learning and mobile learning obtained the fact that each of them has advantages and disadvantages in each field. For more details, see Table 6 below.

Table 6. Advantages and disadvantages of digital learning and mobile learning.

Digital Learning	Mobile Learning
Advantages	
● Relatively expensive according to the device used ● Learning depends on the device used (for example, a computer should not be used while traveling while a tablet can be used anywhere)	● Relatively inexpensive because it only uses certain ● cellphones Learning can be done anywhere, anytime, and is personalized ● Can eliminate some formal learning and make it more interesting

Digital Learning	Mobile Learning
● Can eliminate some formal learning and make it more interesting ● Types of wireless communication to access all information ● Multiple delivery and content creation options ● Facilitates both individual and collaborative learning experiences ● helps provide and support literacy, numeracy and language learning ● Can increase self-confidence in education ● Increase skills in using technology in learning activities ● Can have discussions without having to meet ● Can use teaching materials as needed ● Support distance ● learning that develops in everyday life ● Learning can be followed by more students	● Types of wireless communication to access all information ● Multiple delivery and content creation options ● Facilitate learning experiences both individually and collaboratively ● to help provide and support literacy, numeracy and language learning ● Can increase self-confidence in education ● Increase skills in using technology in learning activities ● Can conduct discussions without having to meet ● Can access teaching materials needed at any time and certainly more attractive ● Easier to carry and use ● Supports distance learning Take ● advantage of emerging technologies in everyday life ● Learning can be followed by more students
Disadvantages	
● Can only be used use by people who can afford ● It Always need internet access ● Quickly makes you bored because you don't see each other ● Practical learning can't be done maximally ● Depends on a good network ● Development and learning is more about knowledge ● Can't monitor students individually ● Learning depends on device battery percentage ● Abstract learning is very difficult to understand ● The atmosphere must be conducive ● Requires a lot of help tools such as, Pen Tab, webcam, a good headset.	● Can only be used by people who can afford ● It always requires internet access ● Limited with storage from the device used ● Large practicum applications cannot be installed ● Depends on a good network ● Development and learning is more about knowledge ● Cannot monitor students individually ● Learning depends on HP battery percentage ● Many mobile differences such as iOS, Android, and Apple that can only be used on certain cell phones ● Atmosphere must be conducive ● Small memory capacity ● Small screen view

Based on Table 6 shows the advantages and disadvantages of digital learning and mobile learning. Digital learning and mobile learning are learning alternatives that are growing rapidly in line with technological developments.

4 Conclusion

Digital learning and mobile learning are two different things but still have something in common. Learning with mobile learning is an innovation from digital learning. Based on Scopus data from 1992 to 2021, digital learning and mobile learning publications have on average experienced a significant increase. This is due to following technological developments and due to the ongoing COVID-19 pandemic. Based on the results that have been presented, it can be seen the trends, differences, similarities, advantages, and disadvantages of digital learning and mobile learning. Thus, it is hoped that this discovery can be a reference for future discoveries in aspects of digital-based learning.

5 Acknowledgment

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Top 100 Cited Publications for The Last Thirty Years in Digital Learning and Mobile Learning

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Abstract—Digital learning and mobile learning are two different things but have something in common. This research aims to find trends, topics, similarities, differences, advantages, and disadvantages of digital learning and mobile learning over the last thirty years (1992 – 2021). The method used in this research is bibliometric analysis with the help of Ms-excel, VOSViewer, and Wordcloud to visualize the metadata obtained from Scopus. The findings show that the trend of digital learning continues to increase from year to year. In addition, it can explain that mobile learning is an innovative part of digital learning with almost the same differences, similarities, advantages, and disadvantages. In the future, it is hoped that further research related to digital learning will continue to develop along with technological developments.

Keywords—Bibliometric, digital learning, mobile learning, VOSViewer

1 Introduction

Education is so important for humans because it is one of the paths to success regardless of origin. This is evidenced by learning and development of knowledge from time to time continues to grow [1][2]. This is compounded by the existence of new policies that continue to change from year to year. There are so many changes that occur in the world of education [3][4]. According to [5][6], education is very important to continue to be developed in order to provide learning opportunities for all groups. In addition, education is included in the world leader's action plan known as the SDGs (Sustainable Development Goals) [7][8]. Major changes occurred during the Covid-19 pandemic. This causes learning to switch from offline (direct) to online (virtual) [9][10]. That way, new innovations and terms have emerged, such as learning platforms, learning applications, digital learning, online learning, web learning, e-modules, e-books, and many more. Several studies have been conducted regarding online learning models including mobile learning, the effectiveness of digital technology, digital readiness, digital comics, and usability of mobile learning apps [11][12][13][14][15].

Digital learning and mobile learning are the main topics of discussion in the world of education today [16][17]. This will certainly continue to grow along with technological developments. However, it is necessary to know about these developments through

research that has been carried out by various authors and institutions by looking at the publications of previous studies to date in the form of conference proceedings, journal articles and other scientific media [18][19]. According to Yeaung et.al [20] , to see the most impactful topics is not easy to access. Therefore, there is a need for bibliometric analysis to identify and explore impactful topics [14][21]. Using bibliometric analysis can provide a valid review quality, visualize salient areas, improve understanding of the distribution of a research topic, and provide clues for future research [22][23][24]. In addition, bibliometric analysis is assisted by using the VOSViewer, MS-Excel, and Word cloud software in visualizing the research results to make it more interesting.

The purpose of this study is to conduct a literature review related to digital learning and mobile learning topics for one hundred cited in the last thirty years from 1992 to 2021 using bibliometric analysis.

2 Methodology

This research is a type of quantitative research based on the Scopus database. Then, using bibliometric analysis that can prove and find novelty and trends in research [25][26][27][28]. Data collection was obtained through a Scopus search as of 23 January 2022 with the following criteria;

Table 1. Screening data

Description	**Digital Learning**	**Mobile Learning**
Keywords	Title (digital AND earning)	Title (mobile AND learning)
Document All Year	6255 Document	9542 document
Document year (1992-2021)	6148 Document	9481 document

Then the metadata is saved in csv format. and risk. After that, further analysis was carried out using software such as MS-Excel, VOSViewer, and WordCloud to make the data display more attractive [25][29][30]. According to Putri et al. [21] the effectiveness of VOSViewer has been proven in a recent study that has been carried out with the Scopus index.

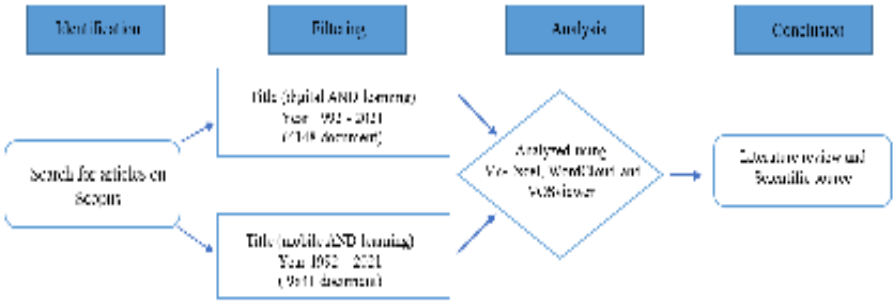
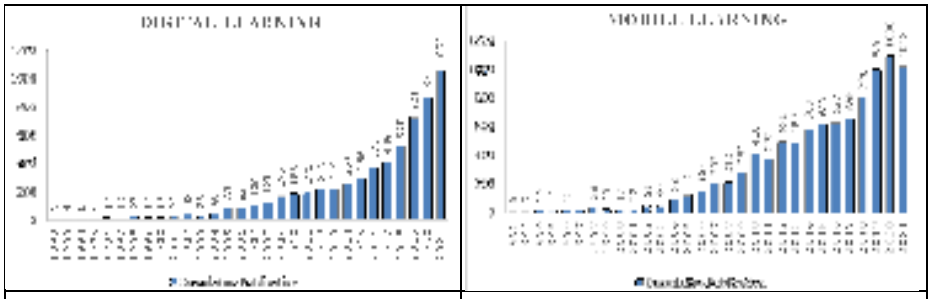


Figure 1. Flowchart research

3 Result and Discussion

3.1 Publication research trend

Figures 1a and 1b show a very significant development in the publication of articles on Scopus over the last thirty years. This shows that the high interest of the academic community towards research and the trends that are developing are very high.



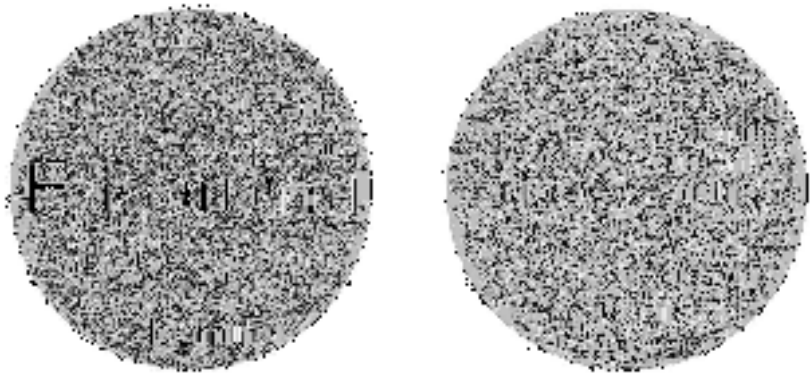
(a) Digital learning (b) Mobile learning

Figure 2. Publication trend digital learning and mobile learning last thirty years

Figure 2 shows the number of articles in the field of digital learning and mobile learning at Scopus.

3.2 Visualization keyword of papers

The most frequently used keywords are graphically shown in Figure 3. Larger font sizes represent the frequency with which words are used the most. Words that are commonly used in digital learning are E-learning, students, human, teach, deep learning, etc. As for mobile learning, the words that are often used are mobile learning, students, E-learning, teaching, mobile application, education, etc.



(a) Digital Learning (b) Mobile Learning

Figure 3. The most relevant keywords

Figure 3a. The network visualization relevance trend in digital learning

Based on Figure 4(a) the relevance trend in digital learning produces three visible color clusters (yellow, green, and purple).

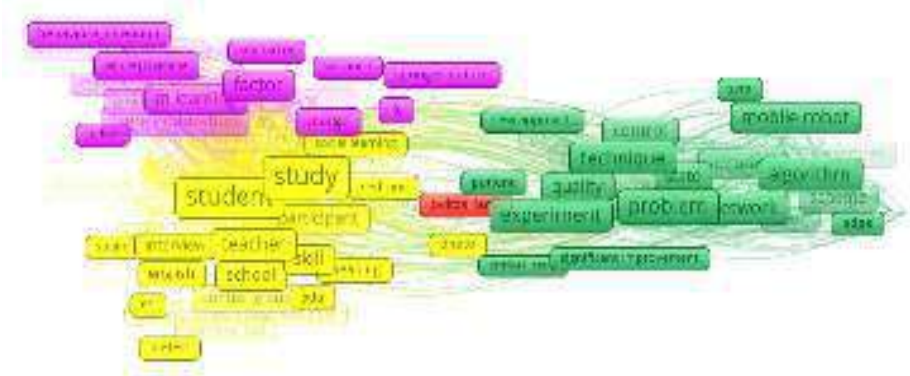


Figure 4b. The network visualization relevance trend in mobile learning

Based on Figure 4(b) the relevance trend in digital learning resulted in four visible color clusters (yellow, green, purple, and red).

3.3 Publication Type

Table 2. Document type of top cited paper

Document Type	Frequency		Total Cited		Mean		Median		SD	
	DL	ML	DL	ML	DL	ML	DL	ML	DL	ML
Article	80	82	13544*	21680*	169.3	264.4	119.0	212.5	158.8	132.8
Conference Paper	8	11	872	2637	109.0	239.7	92.0	229.0	45.9	65.7
Book	6	2	905	666	150.5	333.0	129.0	333.0	61.8	79.2
Review	4	4	758	1363	189.0*	340.8*	204.0*	339.5*	95.7	103.2

Book Chapter	1	1	88	299	88.0	299.0	88.0	299.0		-
Editorial	1	-	363	-	363.0	-	363.0	-	-	-
Total	**100**	**100**	**16530**	**26647**	**1069.6**	**1477.9**	**-**	**-**	**-**	**-**
*=the highest number										

Document types from the top 100 papers published in digital learning and mobile learning from 1992 to 2021 can be seen in Table 2.

3.4 Distribution of Top Cited 100 Paper

Table 2. Distribution paper

Digital Learning						Mobile Learning					
Year	**Paper**	**Citation**	**ACPP**	**HAPPY**	**City Year**	**Year**	**Paper**	**Citation**	**ACPP**	**HAPPY**	**Citable**
1992	1	95	95.0	3.2	30	1995	1	202	202.0	7.5	27
1995	2	215	107.5	4.0	27	1996	1	222	222.0	8.5	26
2001	2	414	207.0	9.9	21	1998	2	903	451.5	18.8	24
2004	2	450	225.0	12.5	18	2000	1	601	601.0*	27.3	22
2005	4	1219	304.8	17.9	17	2002	4	872	218.0	10.9	20
2006	2	261	130.5	8.2	16	2003	6	1368	228.0	12.0	19
2007	5	878	175.6	11.7	15	2004	2	471	235.5	13.1	18
2008	5	844	168.8	12.1	14	2005	2	614	307.0	18.1	17
2009	7	2253	321.9*	24.8	13	2006	1	160	160.0	10.0	16
2010	3	410	136.7	11.4	12	2007	8	2170	271.3	18.1	15
2011	7	904	129.1	11.7	11	2008	6	2364	394.0	28.1	14
2012	10	1298	129.8	13.0	10	2009	10*	2856*	285.6	22.0	13
2013	7	1159	165.6	18.4	9	2010	8	1923	240.4	20.0	12
2014	8	860	107.5	13.4	8	2011	7	2328	332.6	30.2	11
2015	4	420	105.0	15.0	7	2012	5	1870	374.0	37.4	10
2016	11*	2433*	221.2	36.9	6	2013	5	1445	289.0	32.1	9
2017	4	5 33	133.3	26.7	5	2014	5	986	197.2	24.7	8
2018	6	807	134.5	33.6	4	2015	2	390	195.0	27.9	7
2019	8	711	88.9	29.6	3	2016	8	2211	276.4	46.1	6
2020	2	274	137.0	68.5*	2	2017	7	1510	215.7	43.1	5
-	-	-	-	-	-	2018	4	774	193.5	48.4	4
-	-	-	-	-	-	2019	4	1181	295.3	98.4*	3
-	-	-	-	-	-	2020	1	225	225.0	112.5	2
Total	100	16438	3224.5	382.3		Total	100	27646	6409.8	715.2	
ACPP= Average Citation Per Paper , ACPPY= Average Citation Per Paper Per Year, *= the highest number											

Based on the Table 2 above, for digital learning and mobile learning, publications do not occur every year.

3.5 Top 10 Authors with more articles

Table 3. Top 10 author with more article

Digital Learning			Mobile Learning		
Author	**Document**	**Country**	**Author**	**Document**	**Country**
Ifenthaler, D	15	Curtin University (Australia)	Hwang, GJ	70	National Taiwan University of Science and Technology (Taiwan)

Digital Learning			Mobile Learning		
Author	**Document**	**Country**	**Author**	**Document**	**Country**
Lam, EY	14	The University of Hong Kong (Hong Kong)	Huang, YM	39	National Cheng Kung University (Taiwan)
Chen, GD	13	National Central University(Taiwan)	Milrad, M	36	Linnaeus University (Sweden)
Barber, W.	12	Ontario Tech University (Canada)	Kukulska-Hulme, A	34	The Open University, Milton Keynes (United Kingdom)
Hwang, GJ	12	National Taiwan University of Science and Technology (Taiwan)	Wong, LH	34	National Institute of Education (Singapore)
Bandung, Y	11	Bandung Institute of Technology (Indonesia)	Traxler, J	30	University of Wolverhampton (United Kingdom)
Lee, JS	11	The Education University of Hong Kong (Hong Kong)	Looi, CK	29	Center for Research and Development in Learning (Singapore)
Erstad, O	9	Universitetet I Oslo (Norway)	Parsons, D	26	The Mind Lab, Auckland (New Zealand)
Huang, YM	9	National Cheng Kung University (Taiwan)	Sharples, M	26	The Open University, Milton Keynes (United Kingdom)
Sampson, DG	9	University of Piraeus (Greece)	Specht, M	24	Delft University of Technology (Netherlands)

Table 3 shows the top 10 authors' articles with the highest number of documents from 1992 to 2021 from different countries.

3.6 Top Country of Publication 100 Highest

Table 4. Top countries 100 cited publication (1992-2021)

Digital Learning				Mobile Learning			
Country	**Article**	**Total Citation**	**Average Article Citation**	**Country**	**Article**	**Total Citation**	**Average Article Citation**
United States	33	6452	195.52	Taiwan	26	8308	319.54
United Kingdom	13	2120	163.08	United States	19	5658	297.79
Taiwan	7	584	83.43	United Kingdom	17	3166	186.24
China	5	435	87.00	Singapore	4	879	219.75
Netherlands	5	1532	306.40	South Korea	3	744	248.00
Australia	4	490	122.50	Switzerland	3	831	277.00
Belgium	4	423	105.75	Australia	3	646	215.33
Finland	4	598	149.50	China	3	626	208.67
Hong Kong	4	548	137.00	Japan	3	622	207.33
Canada	3	1187	395.67	Netherlands	2	373	186.50
Germany	3	475	158.33	Germany	2	400	200.00
South Korea	3	510	170.00	Italy	2	382	191.00

Digital Learning				Mobile Learning			
Country	**Article**	**Total Citation**	**Average Article Citation**	**Country**	**Article**	**Total Citation**	**Average Article Citation**
France	1	295	295.00	Turkey	2	353	176.50
Greece	1	984	984.00	Canada	2	400	200.00
Italy	1	74	74.00	South Africa	1	303	303.00
New Zealand	1	137	137.00	Nigeria	1	300	300.00
Norway	1	81	81.00	Hong Kong	1	285	285.00
Oman	1	292	292.00	Malaysia	1	213	213.00
Russian	1	77	77.00	Spain	1	196	196.00
Singapore	1	189	189.00	Portugal	1	180	180.00
Spain	1	305	305.00	Chile	1	170	170.00
Switzerland	1	105	105.00	Finland	1	163	163.00
Thailand	1	74	74.00	France	1	162	162.00
Turkey	1	71	71.00	-	-	-	-
Total	100	18038	4758.2	**Total**	**100**	**25277**	**5061.3**

The calculation of the publication of articles from countries is only based on the affiliation that published the articles. Table 4 shows that there are country differences between the top 100 digital learning papers and the top 100 mobile learning papers.

3.7 Top 10 Productive Countries

When analyzing we found the leading countries that have the most publications on digital learning and mobile learning. Each of the top three countries that have the most publications during 1991 to 2021 are the United States (1354 doc), United Kingdom (456 doc), and China (407 doc) for digital learning which can be seen in Figure 5a. As for mobile learning, the top three countries that have the most publications during 1991 to 2021 are China (1390 docs), United States (1359 docs), and United Kingdom (659 docs) which can be seen in Figure 5b.

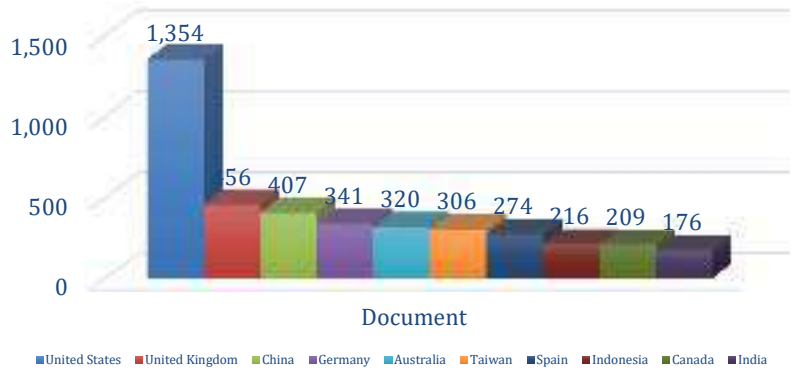


Figure 5a. Top 10 productive countries digital learning

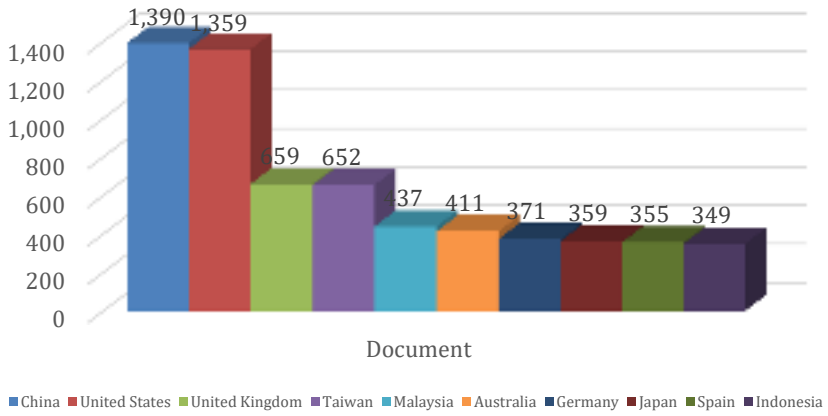


Figure 5b. Top 10 productive countries mobile learning

3.8 The differences and similarities between digital learning and mobile learning

After reviewing literature and other scientific sources, facts are obtained which state that there are so many differences and similarities between digital learning and mobile learning. That way, it is important to discuss this so that it can reduce misconceptions about digital learning and mobile learning. For more details presented in table.5

Table 5. Differences and similarities digital learning and mobile learning

Description	Digital Learning	Mobile Learning
Understanding	Digital learning is a digital learning resource that includes many elements to be used in learning [32]	Mobile learning is a learning model that adopts the development of mobile technology and mobile devices (HP) as a learning medium[33]
Function	Facilitates the learning process and presents more interesting teaching materials [32]	As an alternative to mobile or mobile-based learning services[34]
Forms/types of	• Blended learning • Online Learning/E-learning • Use of technology (applications, google, and the like) • Adaptive learning	• Applications • Web
Existence	continues to grow	Continuously develops

Description	Digital Learning	Mobile Learning
Devices	HP, notebook, Tablet, PDA, Computer, Web, PC, Tv, CD-ROM, and etc	Mobile, notebook, tablet, smartphone and PDAs.
Features	Video Streaming/live, virtual whiteboards, quizzes/virtual exams, discussion threads, online questionnaires, online TV, and etc [35]	Features that can be used Based on the type of application installed [36]
Scope	Covers all bases digital	According to the specs of the device used
Approach	All media	Certain applications
Size	Flexible	According to device
Application	All applications	Limited applications
Place	Virtual Classroom online, teachers in class, and internet labs	Flexible learning (anywhere and anytime)
Access	Internet	Internet

Based on Table 5 shows the differences and similarities between digital learning and mobile learning.

Figure 6. relationship illustration digital learning and mobile learning

3.9 The advantages and disadvantages of digital learning and mobile learning

The results of the study of literature and scientific sources related to the topic of digital learning and mobile learning obtained the fact that each of them has advantages and disadvantages in each field. For more details, see Table 6 below.

Table 6. Advantages and disadvantages of digital learning and mobile learning.

Digital Learning	Mobile Learning
Advantages	
● Relatively expensive according to the device used ● Learning depends on the device used (for example, a computer should not be used while traveling while a tablet can be used anywhere)	● Relatively inexpensive because it only uses certain ● cellphones Learning can be done anywhere, anytime, and is personalized ● Can eliminate some formal learning and make it more interesting

Digital Learning	Mobile Learning
● Can eliminate some formal learning and make it more interesting ● Types of wireless communication to access all information ● Multiple delivery and content creation options ● Facilitates both individual and collaborative learning experiences ● helps provide and support literacy, numeracy and language learning ● Can increase self-confidence in education ● Increase skills in using technology in learning activities ● Can have discussions without having to meet ● Can use teaching materials as needed ● Support distance ● learning that develops in everyday life ● Learning can be followed by more students	● Types of wireless communication to access all information ● Multiple delivery and content creation options ● Facilitate learning experiences both individually and collaboratively ● to help provide and support literacy, numeracy and language learning ● Can increase self-confidence in education ● Increase skills in using technology in learning activities ● Can conduct discussions without having to meet ● Can access teaching materials needed at any time and certainly more attractive ● Easier to carry and use ● Supports distance learning Take ● advantage of emerging technologies in everyday life ● Learning can be followed by more students
Disadvantages	
● Can only be used use by people who can afford ● It Always need internet access ● Quickly makes you bored because you don't see each other ● Practical learning can't be done maximally ● Depends on a good network ● Development and learning is more about knowledge ● Can't monitor students individually ● Learning depends on device battery percentage ● Abstract learning is very difficult to understand ● The atmosphere must be conducive ● Requires a lot of help tools such as, Pen Tab, webcam, a good headset.	● Can only be used by people who can afford ● It always requires internet access ● Limited with storage from the device used ● Large practicum applications cannot be installed ● Depends on a good network ● Development and learning is more about knowledge ● Cannot monitor students individually ● Learning depends on HP battery percentage ● Many mobile differences such as iOS, Android, and Apple that can only be used on certain cell phones ● Atmosphere must be conducive ● Small memory capacity ● Small screen view

Based on Table 6 shows the advantages and disadvantages of digital learning and mobile learning. Digital learning and mobile learning are learning alternatives that are growing rapidly in line with technological developments.

4 Conclusion

Digital learning and mobile learning are two different things but still have something in common. Learning with mobile learning is an innovation from digital learning. Based on Scopus data from 1992 to 2021, digital learning and mobile learning publications have on average experienced a significant increase. This is due to following technological developments and due to the ongoing COVID-19 pandemic. Based on the results that have been presented, it can be seen the trends, differences, similarities, advantages, and disadvantages of digital learning and mobile learning. Thus, it is hoped that this discovery can be a reference for future discoveries in aspects of digital-based learning.

5 Acknowledgment

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Top 100 Cited Publications for The Last Thirty Years in Digital Learning and Mobile Learning

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Abstract—Digital learning and mobile learning are two different things but have something in common. This research aims to find trends, topics, similarities, differences, advantages, and disadvantages of digital learning and mobile learning over the last thirty years (1992 – 2021). The method used in this research is bibliometric analysis with the help of Ms-excel, VOSViewer, and Wordcloud to visualize the metadata obtained from Scopus. The findings show that the trend of digital learning continues to increase from year to year. In addition, it can explain that mobile learning is an innovative part of digital learning with almost the same differences, similarities, advantages, and disadvantages. In the future, it is hoped that further research related to digital learning will continue to develop along with technological developments.

Keywords—Bibliometric, digital learning, mobile learning, VOSViewer

1 Introduction

Education is so important for humans because it is one of the paths to success regardless of origin. This is evidenced by learning and development of knowledge from time to time continues to grow [1][2]. This is compounded by the existence of new policies that continue to change from year to year. There are so many changes that occur in the world of education [3][4]. According to [5][6], education is very important to continue to be developed in order to provide learning opportunities for all groups. In addition, education is included in the world leader's action plan known as the SDGs (Sustainable Development Goals) [7][8]. Major changes occurred during the Covid-19 pandemic. This causes learning to switch from offline (direct) to online (virtual) [9][10]. That way, new innovations and terms have emerged, such as learning platforms, learning applications, digital learning, online learning, web learning, e-modules, e-books, and many more. Several studies have been conducted regarding online learning models including mobile learning, the effectiveness of digital technology, digital readiness, digital comics, and usability of mobile learning apps [11][12][13][14][15].

Digital learning and mobile learning are the main topics of discussion in the world of education today [16][17]. This will certainly continue to grow along with technological developments. However, it is necessary to know about these developments through research that has been carried out by various authors and institutions by looking at the publications of previous studies to date in the form of conference proceedings, journal articles and other scientific media [18][19]. According to Yeaung et.al [20] , to see the most impactful topics is not easy to access. Therefore, there is a need for bibliometric

analysis to identify and explore impactful topics [14][21]. Using bibliometric analysis can provide a valid review quality, visualize salient areas, improve understanding of the distribution of a research topic, and provide clues for future research [22][23][24]. In addition, bibliometric analysis is assisted by using the VOSViewer, MS-Excel, and Word cloud software in visualizing the research results to make it more interesting. The purpose of this study is to conduct a literature review related to digital learning and mobile learning topics for one hundred cited in the last thirty years from 1992 to 2021 using bibliometric analysis.

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2 Methodology

This research is a type of quantitative research based on the Scopus database. Then, using bibliometric analysis that can prove and find novelty and trends in research [25][26][27][28]. Data collection was obtained through a Scopus search as of 23 January 2022 with the following criteria;

Table 1. Screening data

Description	**Digital Learning**	**Mobile Learning**
Keywords	Title (digital AND earning)	Title (mobile AND learning)
Document All Year	6255 Document	9542 document
Document year (1992-2021)	6148 Document	9481 document

Then the metadata is saved in csv format. and risk. After that, further analysis was carried out using software such as MS-Excel, VOSViewer, and WordCloud to make the data display more attractive [25][29][30]. According to Putri et al. [21] the effectiveness of VOSViewer has been proven in a recent study that has been carried out with the Scopus index.

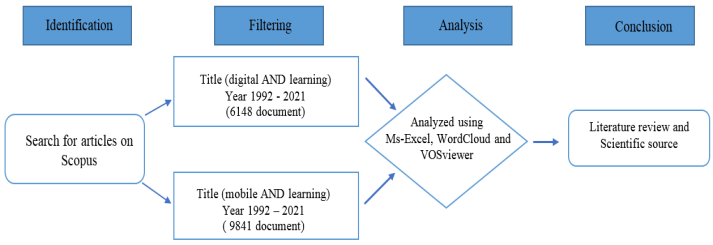
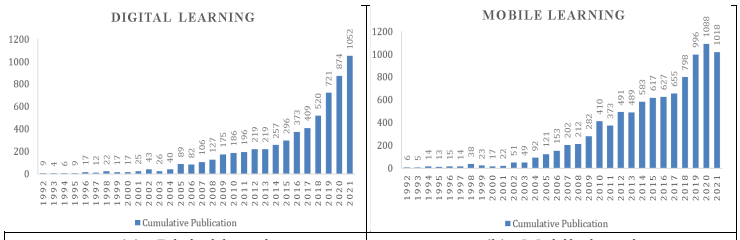


Figure 1. Flowchart research

3 Result and Discussion

3.1 Publication research trend

Figures 1a and 1b show a very significant development in the publication of articles on Scopus over the last thirty years. This shows that the high interest of the academic community towards research and the trends that are developing are very high.



(a) Digital learning (b) Mobile learning

Figure 2. Publication trend digital learning and mobile learning last thirty years

Figure 2 shows the number of articles in the field of digital learning and mobile learning at Scopus.

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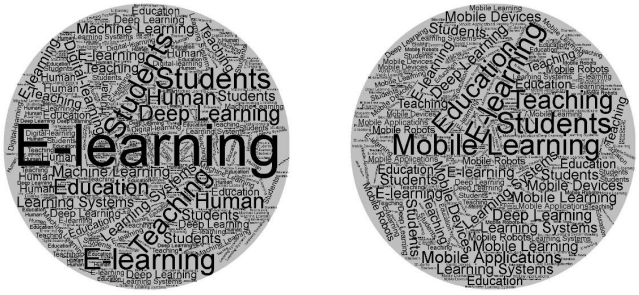
3.2 Visualization keyword of papers

The most frequently used keywords are graphically shown in Figure 3. Larger font sizes represent the frequency with which words are used the most. Words that are commonly used in digital learning are E-learning, students, human, teach, deep learning, etc. As for mobile learning, the words that are often used are mobile learning, students, E-learning, teaching, mobile application, education, etc.



(a) Digital Learning (b) Mobile Learning

Figure 3. The most relevant keywords

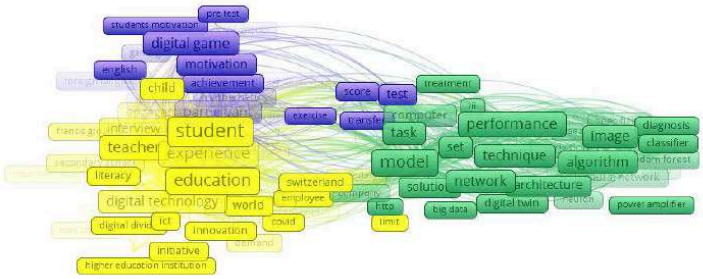


Figure 3a. The network visualization relevance trend in digital learning

Based on Figure 4(a) the relevance trend in digital learning produces three visible color clusters (yellow, green, and purple).

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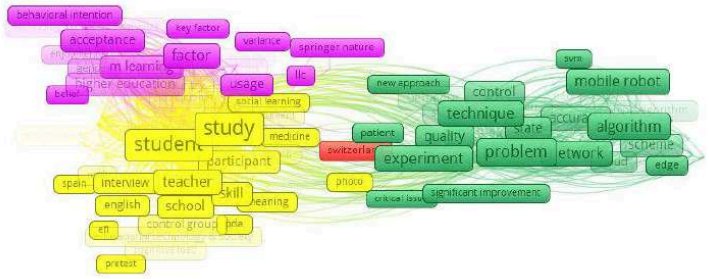

Figure 4b. The network visualization relevance trend in mobile learning

Based on Figure 4(b) the relevance trend in digital learning resulted in four visible color clusters (yellow, green, purple, and red).

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3.3 Publication Type

Table 2. Document type of top cited paper

Document Type	Frequency		Total Cited		Mean		Median		SD	
	DL	ML	DL	ML	DL	ML	DL	ML	DL	ML
Article	80	82	13544*	21680*	169.3	264.4	119.0	212.5	158.8	132.8
Conference Paper	8	11	872	2637	109.0	239.7	92.0	229.0	45.9	65.7
Book	6	2	905	666	150.5	333.0	129.0	333.0	61.8	79.2
Review	4	4	758	1363	189.0*	340.8*	204.0*	339.5*	95.7	103.2

Book Chapter	1	1	88	299	88.0	299.0	88.0	299.0		-
Editorial	1	-	363	-	363.0	-	363.0	-	-	-
Total	**100**	**100**	**16530**	**26647**	**1069.6**	**1477.9**	**-**	**-**	**-**	**-**
*=the highest number										

Document types from the top 100 papers published in digital learning and mobile learning from 1992 to 2021 can be seen in Table 2.

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3.4 Distribution of Top Cited 100 Paper

Table 2. Distribution paper

Digital Learning						Mobile Learning					
Year	**Paper**	**Citation**	**ACPP**	**HAPPY**	**City Year**	**Year**	**Paper**	**Citation**	**ACPP**	**HAPPY**	**Citable**
1992	1	95	95.0	3.2	30	1995	1	202	202.0	7.5	27
1995	2	215	107.5	4.0	27	1996	1	222	222.0	8.5	26
2001	2	414	207.0	9.9	21	1998	2	903	451.5	18.8	24
2004	2	450	225.0	12.5	18	2000	1	601	601.0*	27.3	22
2005	4	1219	304.8	17.9	17	2002	4	872	218.0	10.9	20
2006	2	261	130.5	8.2	16	2003	6	1368	228.0	12.0	19
2007	5	878	175.6	11.7	15	2004	2	471	235.5	13.1	18
2008	5	844	168.8	12.1	14	2005	2	614	307.0	18.1	17
2009	7	2253	321.9*	24.8	13	2006	1	160	160.0	10.0	16
2010	3	410	136.7	11.4	12	2007	8	2170	271.3	18.1	15
2011	7	904	129.1	11.7	11	2008	6	2364	394.0	28.1	14
2012	10	1298	129.8	13.0	10	2009	10*	2856*	285.6	22.0	13
2013	7	1159	165.6	18.4	9	2010	8	1923	240.4	20.0	12
2014	8	860	107.5	13.4	8	2011	7	2328	332.6	30.2	11
2015	4	420	105.0	15.0	7	2012	5	1870	374.0	37.4	10
2016	11*	2433*	221.2	36.9	6	2013	5	1445	289.0	32.1	9
2017	4	5 33	133.3	26.7	5	2014	5	986	197.2	24.7	8
2018	6	807	134.5	33.6	4	2015	2	390	195.0	27.9	7
2019	8	711	88.9	29.6	3	2016	8	2211	276.4	46.1	6
2020	2	274	137.0	68.5*	2	2017	7	1510	215.7	43.1	5
-	-	-	-	-	-	2018	4	774	193.5	48.4	4
-	-	-	-	-	-	2019	4	1181	295.3	98.4*	3
-	-	-	-	-	-	2020	1	225	225.0	112.5	2
Total	100	16438	3224.5	382.3		Total	100	27646	6409.8	715.2	
ACPP= Average Citation Per Paper , ACPPY= Average Citation Per Paper Per Year, *= the highest number											

Based on the Table 2 above, for digital learning and mobile learning, publications do not occur every year.

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3.5 Top 10 Authors with more articles

Table 3. Top 10 author with more article

Digital Learning			Mobile Learning		
Author	**Document**	**Country**	**Author**	**Document**	**Country**
Ifenthaler, D	15	Curtin University (Australia)	Hwang, GJ	70	National Taiwan University of Science and Technology (Taiwan)

Digital Learning			Mobile Learning		
Author	**Document**	**Country**	**Author**	**Document**	**Country**
Lam, EY	14	The University of Hong Kong (Hong Kong)	Huang, YM	39	National Cheng Kung University (Taiwan)
Chen, GD	13	National Central University(Taiwan)	Milrad, M	36	Linnaeus University (Sweden)
Barber, W.	12	Ontario Tech University (Canada)	Kukulska-Hulme, A	34	The Open University, Milton Keynes (United Kingdom)
Hwang, GJ	12	National Taiwan University of Science and Technology (Taiwan)	Wong, LH	34	National Institute of Education (Singapore)
Bandung, Y	11	Bandung Institute of Technology (Indonesia)	Traxler, J	30	University of Wolverhampton (United Kingdom)
Lee, JS	11	The Education University of Hong Kong (Hong Kong)	Looi, CK	29	Center for Research and Development in Learning (Singapore)
Erstad, O	9	Universitetet I Oslo (Norway)	Parsons, D	26	The Mind Lab, Auckland (New Zealand)
Huang, YM	9	National Cheng Kung University (Taiwan)	Sharples, M	26	The Open University, Milton Keynes (United Kingdom)
Sampson, DG	9	University of Piraeus (Greece)	Specht, M	24	Delft University of Technology (Netherlands)

Table 3 shows the top 10 authors' articles with the highest number of documents from 1992 to 2021 from different countries.

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3.6 Top Country of Publication 100 Highest

Table 4. Top countries 100 cited publication (1992-2021)

Digital Learning				Mobile Learning			
Country	**Article**	**Total Citation**	**Average Article Citation**	**Country**	**Article**	**Total Citation**	**Average Article Citation**
United States	33	6452	195.52	Taiwan	26	8308	319.54
United Kingdom	13	2120	163.08	United States	19	5658	297.79
Taiwan	7	584	83.43	United Kingdom	17	3166	186.24
China	5	435	87.00	Singapore	4	879	219.75
Netherlands	5	1532	306.40	South Korea	3	744	248.00
Australia	4	490	122.50	Switzerland	3	831	277.00
Belgium	4	423	105.75	Australia	3	646	215.33
Finland	4	598	149.50	China	3	626	208.67
Hong Kong	4	548	137.00	Japan	3	622	207.33
Canada	3	1187	395.67	Netherlands	2	373	186.50
Germany	3	475	158.33	Germany	2	400	200.00
South Korea	3	510	170.00	Italy	2	382	191.00

Digital Learning				Mobile Learning			
Country	**Article**	**Total Citation**	**Average Article Citation**	**Country**	**Article**	**Total Citation**	**Average Article Citation**
France	1	295	295.00	Turkey	2	353	176.50
Greece	1	984	984.00	Canada	2	400	200.00
Italy	1	74	74.00	South Africa	1	303	303.00
New Zealand	1	137	137.00	Nigeria	1	300	300.00
Norway	1	81	81.00	Hong Kong	1	285	285.00
Oman	1	292	292.00	Malaysia	1	213	213.00
Russian	1	77	77.00	Spain	1	196	196.00
Singapore	1	189	189.00	Portugal	1	180	180.00
Spain	1	305	305.00	Chile	1	170	170.00
Switzerland	1	105	105.00	Finland	1	163	163.00
Thailand	1	74	74.00	France	1	162	162.00
Turkey	1	71	71.00	-	-	-	-
Total	100	18038	4758.2	**Total**	**100**	**25277**	**5061.3**

The calculation of the publication of articles from countries is only based on the affiliation that published the articles. Table 4 shows that there are country differences between the top 100 digital learning papers and the top 100 mobile learning papers.

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3.7 Top 10 Productive Countries

When analyzing we found the leading countries that have the most publications on digital learning and mobile learning. Each of the top three countries that have the most publications during 1991 to 2021 are the United States (1354 doc), United Kingdom (456 doc), and China (407 doc) for digital learning which can be seen in Figure 5a. As for mobile learning, the top three countries that have the most publications during 1991 to 2021 are China (1390 docs), United States (1359 docs), and United Kingdom (659 docs) which can be seen in Figure 5b.

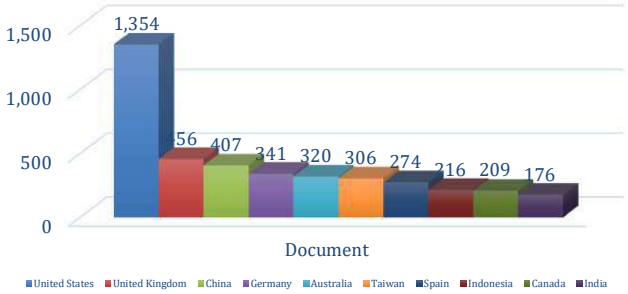

Figure 5a. Top 10 productive countries digital learning

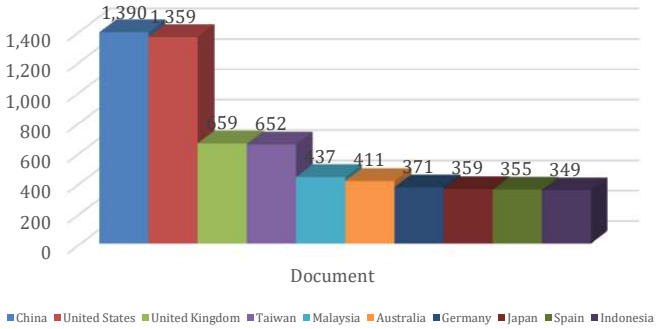

Figure 5b. Top 10 productive countries mobile learning

3.8 The differences and similarities between digital learning and mobile learning

After reviewing literature and other scientific sources, facts are obtained which state that there are so many differences and similarities between digital learning and mobile learning. That way, it is important to discuss this so that it can reduce misconceptions about digital learning and mobile learning. For more details presented in Table.5

Table 5. Differences and similarities digital learning and mobile learning

Description	Digital Learning	Mobile Learning
Understanding	Digital learning is a digital learning resource that includes many elements to be used in learning [32]	Mobile learning is a learning model that adopts the development of mobile technology and mobile devices (HP) as a learning medium [33]
Function	Facilitates the learning process and presents more interesting teaching materials [32]	As an alternative to mobile or mobile-based learning services [34]
Forms/types of	● Blended learning ● Online Learning/E-learning ● Use of technology (applications, google, and the like) ● Adaptive learning	● Applications ● Web
Existence	continues to grow	Continuously develops
Devices	HP, notebook, Tablet, PDA, Computer, Web, PC, Tv, CD-ROM, and etc	Mobile, notebook, tablet, smartphone and PDAs.

Description	Digital Learning	Mobile Learning
Features	Video Streaming/live, virtual white-boards, quizzes/virtual exams, discussion threads, online questionnaires, online TV, and etc [35]	Features that can be used Based on the type of application installed [36]
Scope	Covers all bases digital	According to the specs of the device used
Approach	All media	Certain applications
Size	Flexible	According to device
Application	All applications	Limited applications
Place	Virtual Classroom online, teachers in class, and internet labs	Flexible learning (anywhere and anytime)
Access	Internet	Internet

Based on Table 5 shows the differences and similarities between digital learning and mobile learning.

Commented [User9]: please be more detailed in discussion

Figure 6. relationship illustration digital learning and mobile learning

3.9 The advantages and disadvantages of digital learning and mobile learning

The results of the study of literature and scientific sources related to the topic of digital learning and mobile learning obtained the fact that each of them has advantages and disadvantages in each field. For more details, see Table 6.

Table 6. Advantages and disadvantages of digital learning and mobile learning.

Digital Learning	Mobile Learning
Advantages	
● Relatively expensive according to the device used ● Learning depends on the device used (for example, a computer should not be used while traveling while a tablet can be used anywhere) ● Can eliminate some formal learning and make it more interesting	● Relatively inexpensive because it only uses certain ● cellphones Learning can be done anywhere, anytime, and is personalized ● Can eliminate some formal learning and make it more interesting ● Types of wireless communication to access all information

Digital Learning	Mobile Learning
● Types of wireless communication to access all information ● Multiple delivery and content creation options ● Facilitates both individual and collaborative learning experiences ● helps provide and support literacy, numeracy and language learning ● Can increase self-confidence in education ● Increase skills in using technology in learning activities ● Can have discussions without having to meet ● Can use teaching materials as needed ● Support distance ● learning that develops in everyday life ● Learning can be followed by more students	● Multiple delivery and content creation options ● Facilitate learning experiences both individually and collaboratively ● to help provide and support literacy, numeracy and language learning ● Can increase self-confidence in education ● Increase skills in using technology in learning activities ● Can conduct discussions without having to meet ● Can access teaching materials needed at any time and certainly more attractive ● Easier to carry and use ● Supports distance learning Take ● advantage of emerging technologies in everyday life ● Learning can be followed by more students
Disadvantages	
● Can only be used use by people who can afford ● It Always need internet access ● Quickly makes you bored because you don't see each other ● Practical learning can't be done maximally ● Depends on a good network ● Development and learning is more about knowledge ● Can't monitor students individually ● Learning depends on device battery percentage ● Abstract learning is very difficult to understand ● The atmosphere must be conducive ● Requires a lot of help tools such as, Pen Tab, webcam, a good headset.	● Can only be used by people who can afford ● It always requires internet access ● Limited with storage from the device used ● Large practicum applications cannot be installed ● Depends on a good network ● Development and learning is more about knowledge ● Cannot monitor students individually ● Learning depends on HP battery percentage ● Many mobile differences such as iOS, Android, and Apple that can only be used on certain cell phones ● Atmosphere must be conducive ● Small memory capacity ● Small screen view

Based on Table 6 shows the advantages and disadvantages of digital learning and mobile learning. Digital learning and mobile learning are learning alternatives that are growing rapidly in line with technological developments.

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4 Conclusion

Digital learning and mobile learning are two different things but still have something in common. Learning with mobile learning is an innovation from digital learning. Based

on Scopus data from 1992 to 2021, digital learning and mobile learning publications have on average experienced a significant increase. This is due to following technological developments and due to the ongoing COVID-19 pandemic. Based on the results that have been presented, it can be seen the trends, differences, similarities, advantages, and disadvantages of digital learning and mobile learning. Thus, it is hoped that this discovery can be a reference for future discoveries in aspects of digital-based learning.

5 Acknowledgment

The author's gratitude goes to to the *Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi Republik Indonesia* who has supported funding.

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Top 100 Cited Publications for The Last Thirty Years in Digital Learning and Mobile Learning

https://doi.org/10.3991/ijim.vx.ix.xxxx

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Abstract—Digital learning and mobile learning are two different things but have something in common. This research aims to find trends, topics, similarities, differences, advantages, and disadvantages of digital learning and mobile learning over the last thirty years (1992 – 2021). The method used in this research is bibliometric analysis with the help of Ms-excel, VOSViewer, and Wordcloud to visualize the metadata obtained from Scopus. The findings show that the trend of digital learning continues to increase from year to year. In addition, it can explain that mobile learning is an innovative part of digital learning with almost the same differences, similarities, advantages, and disadvantages. In the future, it is hoped that further research related to digital learning will continue to develop along with technological developments.

Keywords—Bibliometric, digital learning, mobile learning, VOSViewer

1 Introduction

Education is so important for humans because it is one of the paths to success regardless of origin. This is evidenced by learning and development of knowledge from time to time continues to grow [1][2]. This is compounded by the existence of new policies that continue to change from year to year. There are so many changes that occur in the world of education [3][4]. According to [5][6], education is very important to continue to be developed in order to provide learning opportunities for all groups. In addition, education is included in the world leader's action plan known as the SDGs (Sustainable Development Goals) [7][8]. Major changes occurred during the Covid-19 pandemic. This causes learning to switch from offline (direct) to online (virtual) [9][10]. That way, new innovations and terms have emerged, such as learning platforms, learning applications, digital learning, online learning, web learning, e-modules, e-books, and many more. Several studies have been conducted regarding online learning models including mobile learning, the effectiveness of digital technology, digital readiness, digital comics, and usability of mobile learning apps [11][12][13][14][15].

Digital learning and mobile learning are the main topics of discussion in the world of education today [16][17]. This will certainly continue to grow along with technological developments. However, it is necessary to know about these developments through

research that has been carried out by various authors and institutions by looking at the publications of previous studies to date in the form of conference proceedings, journal articles and other scientific media [18][19]. According to Yeaung et.al [20] , to see the most impactful topics is not easy to access. Therefore, there is a need for bibliometric analysis to identify and explore impactful topics [14][21]. Using bibliometric analysis can provide a valid review quality, visualize salient areas, improve understanding of the distribution of a research topic, and provide clues for future research [22][23][24]. In addition, bibliometric analysis is assisted by using the VOSViewer, MS-Excel, and Word cloud software in visualizing the research results to make it more interesting.

The purpose of this study is to conduct a literature review related to digital learning and mobile learning topics for one hundred cited in the last thirty years from 1992 to 2021 using bibliometric analysis. There are several research questions were asked to help achieve the specific research problem:

1) What are the trends of publication from 1992 to 2021 in digital learning and mobile learning?
2) What are the types of publication of the top one hundred cited papers in digital learning and mobile learning?
3) How is the distribution of the top 100 papers quoted from digital learning and mobile learning?
4) Who are the prolific authors of the top one hundred cited papers in digital learning and mobile learning?
5) Which countries are most interested in digital learning research and mobile learning?
6) What are the differences and similarities between digital learning and mobile learning?
7) What are the advantages and disadvantages of digital learning and mobile learning?

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2 Methodology

This research is a type of quantitative research based on the Scopus database. Then, using bibliometric analysis that can prove and find novelty and trends in research [25][26][27][28]. Data collection was obtained through a Scopus search as of 23 January 2022 with the following criteria;

Table 1. Screening data

Description	Digital Learning	Mobile Learning
Keywords	Title (digital AND earning)	Title (mobile AND learning)
Document All Year	6255 Document	9542 document
Document year (1992-2021)	6148 Document	9481 document

Then the metadata is saved in csv format. and risk. After that, further analysis was carried out using software such as MS-Excel, VOSViewer, and WordCloud to make

the data display more attractive [25][29][30]. According to Putri et al. [21] the effectiveness of VOSViewer has been proven in a recent study that has been carried out with the Scopus index.

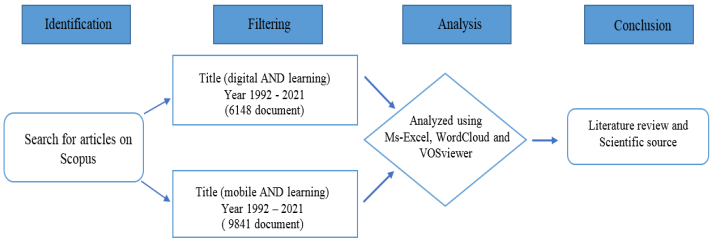
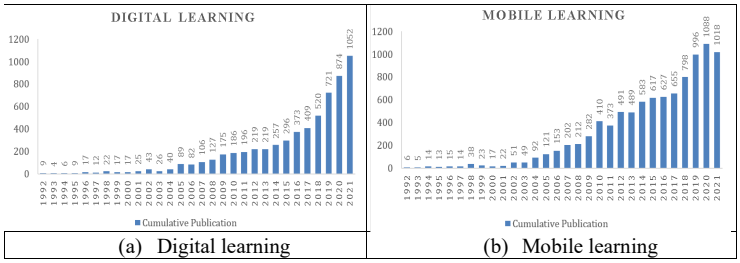


Figure 1. Flowchart research

3 Result and Discussion

3.1 Publication research trend

Figures 1a and 1b show a very significant development in the publication of articles on Scopus over the last thirty years. This shows that the high interest of the academic community towards research and the trends that are developing are very high.



(a) Digital learning (b) Mobile learning

Figure 2. Publication trend digital learning and mobile learning last thirty years

Figure 2 shows the number of articles in the field of digital learning and mobile learning at Scopus. Digital learning in 1992 only amounted to 9 documents. Then the increase occurred continuously which finally in 2021 the published articles had reached thousands, namely 1052 documents. Whereas mobile learning in 1992 only amounted to 6 documents. Then the increase occurred continuously which finally in 2021 the published articles had reached thousands, namely 1018 documents.

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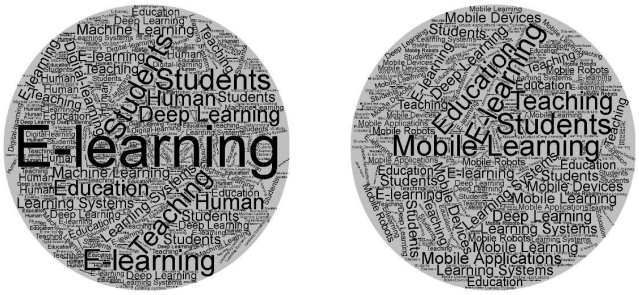
3.2 Visualization keyword of papers

The most frequently used keywords are graphically shown in Figure 3. Larger font sizes represent the frequency with which words are used the most. Words that are commonly used in digital learning are E-learning, students, human, teach, deep learning, etc. As for mobile learning, the words that are often used are mobile learning, students, E-learning, teaching, mobile application, education, etc.



(a) Digital Learning (b) Mobile Learning

Figure 3. The most relevant keywords

From 1992 to 2021 there were 6148 Scopus indexed documents with the topic of digital learning. As for the topic of mobile learning from 1992 to 2021, there are 9481 documents. Then the researcher visualized the trend of the topic with the help of VOSViewer which is presented in Figures 3a and 3b. In addition, the brightest color indicates the most updated word related to the BDAG [37].

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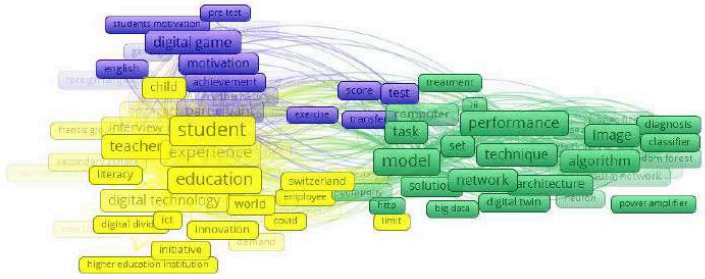

Figure 3a. The network visualization relevance trend in digital learning

Based on Figure 4(a) the relevance trend in digital learning produces three visible color clusters (yellow, green, and purple). In the first cluster (yellow color) are student, education, limit, initiative, higher education institution, innovation, ict, covid, world, digital technology, employee, switzerland, literacy, teacher, experience, interview, and etc. The second cluster (green color) is model, http, big data, solution, task, computer,

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treatment, set, performance, technique, network, digital twin, architecture, algorithm, image, power amplifier, classifier, diagnosis, and etc. The third cluster (purple color) is test, transfer, exercise, score, achievement, motivation, digital game, english, pre test, students motivation, and etc. In addition, the lightest color indicates the most updated word related to the topics [37].

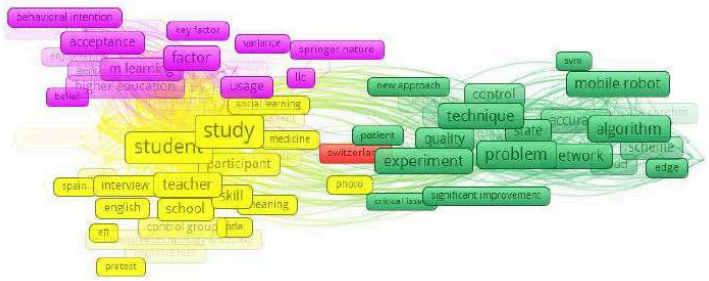

Figure 4b. The network visualization relevance trend in mobile learning

Based on Figure 4(b) the relevance trend in digital learning resulted in four visible color clusters (yellow, green, purple, and red). In the first cluster (yellow color) are study, student, participant, teacher, skill, learning, school, pretest, english, spain, interview, control group, social learning, medicine, photo, and etc. The second cluster (green) is problem, critical issue, significant improvement, experiment, patient, quality, technique, new approach, control, state, network, algorithm, mobile robot, edge, and etc. The third cluster (purple) is usage, ilc, springer nature, variance, factor, key factor, m-learning, belief, higher education, acceptance, behavioral intention, and etc. Cluster four (red) is Switzerland.

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3.3 Publication Type

Table 2. Document type of top cited paper

Document Type	Frequency		Total Cited		Mean		Median		SD	
	DL	ML	DL	ML	DL	ML	DL	ML	DL	ML
Article	80	82	13544*	21680*	169.3	264.4	119.0	212.5	158.8	132.8
Conference Paper	8	11	872	2637	109.0	239.7	92.0	229.0	45.9	65.7
Book	6	2	905	666	150.5	333.0	129.0	333.0	61.8	79.2
Review	4	4	758	1363	189.0*	340.8*	204.0*	339.5*	95.7	103.2
Book Chapter	1	1	88	299	88.0	299.0	88.0	299.0		-
Editorial	1	-	363	-	363.0	-	363.0	-	-	-
Total	**100**	**100**	**16530**	**26647**	**1069.6**	**1477.9**	**-**	**-**	**-**	**-**
*=the highest number										

Document types from the top 100 papers published in digital learning and mobile learning from 1992 to 2021 can be seen in Table 2. The 100 papers for digital learning has six document types, namely, articles (80), Conference paper (8), Book (6), Review (4), Book Chapter (1), and Editorial (1). In addition, the highest and lowest average number of review citations are (363.0) and (88.0) respectively, with the highest standard deviation (158.8). Meanwhile, for 100 mobile learning papers, there are five types of documents, namely articles (82), conference papers (11), books (2), reviews (4), and book chapters (1). Furthermore, for the highest and lowest average number of review citations, respectively (340.0) and (239.0) with the highest standard deviation (132.8).

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3.4 Distribution of Top Cited 100 Paper

Table 2. Distribution paper

Digital Learning						Mobile Learning					
Year	**Paper**	**Citation**	**ACPP**	**HAPPY**	**City Year**	**Year**	**Paper**	**Citation**	**ACPP**	**HAPPY**	**Citable**
1992	1	95	95.0	3.2	30	1995	1	202	202.0	7.5	27
1995	2	215	107.5	4.0	27	1996	1	222	222.0	8.5	26
2001	2	414	207.0	9.9	21	1998	2	903	451.5	18.8	24
2004	2	450	225.0	12.5	18	2000	1	601	601.0*	27.3	22
2005	4	1219	304.8	17.9	17	2002	4	872	218.0	10.9	20
2006	2	261	130.5	8.2	16	2003	6	1368	228.0	12.0	19
2007	5	878	175.6	11.7	15	2004	2	471	235.5	13.1	18
2008	5	844	168.8	12.1	14	2005	2	614	307.0	18.1	17
2009	7	2253	321.9*	24.8	13	2006	1	160	160.0	10.0	16
2010	3	410	136.7	11.4	12	2007	8	2170	271.3	18.1	15
2011	7	904	129.1	11.7	11	2008	6	2364	394.0	28.1	14
2012	10	1298	129.8	13.0	10	2009	10*	2856*	285.6	22.0	13
2013	7	1159	165.6	18.4	9	2010	8	1923	240.4	20.0	12
2014	8	860	107.5	13.4	8	2011	7	2328	332.6	30.2	11
2015	4	420	105.0	15.0	7	2012	5	1870	374.0	37.4	10
2016	11*	2433*	221.2	36.9	6	2013	5	1445	289.0	32.1	9
2017	4	5 33	133.3	26.7	5	2014	5	986	197.2	24.7	8
2018	6	807	134.5	33.6	4	2015	2	390	195.0	27.9	7
2019	8	711	88.9	29.6	3	2016	8	2211	276.4	46.1	6
2020	2	274	137.0	68.5*	2	2017	7	1510	215.7	43.1	5
-	-	-	-	-	-	2018	4	774	193.5	48.4	4
-	-	-	-	-	-	2019	4	1181	295.3	98.4*	3
-	-	-	-	-	-	2020	1	225	225.0	112.5	2
Total	100	16438	3224.5	382.3		Total	100	27646	6409.8	715.2	
ACPP= Average Citation Per Paper , ACPPY= Average Citation Per Paper Per Year, *= the highest number											

Based on the Table 2 above, for digital learning and mobile learning, publications do not occur every year. This can be seen in the years that have no paper at all. Furthermore, the top 100 articles on digital learning obtained a total of citations (16438) with an average of (3224.5) citations. The highest citation is (2433) in 2016, the highest average citation is (321.9) in 2009, and the highest average citation per paper per year is (68.5) in 2020. As for mobile learning, it gets a total of citations (27646) with an average (6409.8) citations. The highest citation is (2856) in 2009, the highest average citation is (601.0) in 2000, and the highest average citation per paper per year is (98.4) in 2019.

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3.5 Top 10 Authors with more articles

Table 3. Top 10 author with more article

Digital Learning			Mobile Learning		
Author	**Document**	**Country**	**Author**	**Document**	**Country**
Ifenthaler, D	15	Curtin University (Australia)	Hwang, GJ	70	National Taiwan University of Science and Technology (Taiwan)
Lam, EY	14	The University of Hong Kong (Hong Kong)	Huang, YM	39	National Cheng Kung University (Taiwan)
Chen, GD	13	National Central University(Taiwan)	Milrad, M	36	Linnaeus University (Sweden)
Barber, W.	12	Ontario Tech University (Canada)	Kukulska-Hulme, A	34	The Open University, Milton Keynes (United Kingdom)
Hwang, GJ	12	National Taiwan University of Science and Technology (Taiwan)	Wong, LH	34	National Institute of Education (Singapore)
Bandung, Y	11	Bandung Institute of Technology (Indonesia)	Traxler, J	30	University of Wolverhampton (United Kingdom)
Lee, JS	11	The Education University of Hong Kong (Hong Kong)	Looi, CK	29	Center for Research and Development in Learning (Singapore)
Erstad, O	9	Universitetet I Oslo (Norway)	Parsons, D	26	The Mind Lab, Auckland (New Zealand)
Huang, YM	9	National Cheng Kung University (Taiwan)	Sharples, M	26	The Open University, Milton Keynes (United Kingdom)
Sampson, DG	9	University of Piraeus (Greece)	Specht, M	24	Delft University of Technology (Netherlands)

Table 3 shows the top 10 authors' articles with the highest number of documents from 1992 to 2021 from different countries. In digital learning, it is dominated by Ifenthaler, D from Curtin University (Australia) with a total of 15 documents, followed by Lam, EY from The University of Hong Kong (Hong Kong) with a total of 14 documents, and followed by Chen, G.D from National Central University(Taiwan) with the number of diemen (13). Meanwhile, for mobile learning, it was dominated by Hwang, GJ from the National Taiwan University of Science and Technology (Taiwan) with a total of (70) documents, followed by Huang, YM from National Cheng Kung University (Taiwan) with 39 documents, and followed by Milrad, M from Linnaeus University (Sweden) with the number of documents (36).

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3.6 Top Country of Publication 100 Highest

Table 4. Top countries 100 cited publication (1992-2021)

Digital Learning				Mobile Learning			
Country	**Article**	**Total Citation**	**Average Article Citation**	**Country**	**Article**	**Total Citation**	**Average Article Citation**
United States	33	6452	195.52	Taiwan	26	8308	319.54
United Kingdom	13	2120	163.08	United States	19	5658	297.79
Taiwan	7	584	83.43	United Kingdom	17	3166	186.24
China	5	435	87.00	Singapore	4	879	219.75
Netherlands	5	1532	306.40	South Korea	3	744	248.00
Australia	4	490	122.50	Switzerland	3	831	277.00
Belgium	4	423	105.75	Australia	3	646	215.33
Finland	4	598	149.50	China	3	626	208.67
Hong Kong	4	548	137.00	Japan	3	622	207.33
Canada	3	1187	395.67	Netherlands	2	373	186.50
Germany	3	475	158.33	Germany	2	400	200.00
South Korea	3	510	170.00	Italy	2	382	191.00
France	1	295	295.00	Turkey	2	353	176.50
Greece	1	984	984.00	Canada	2	400	200.00
Italy	1	74	74.00	South Africa	1	303	303.00
New Zealand	1	137	137.00	Nigeria	1	300	300.00
Norway	1	81	81.00	Hong Kong	1	285	285.00
Oman	1	292	292.00	Malaysia	1	213	213.00
Russian	1	77	77.00	Spain	1	196	196.00
Singapore	1	189	189.00	Portugal	1	180	180.00
Spain	1	305	305.00	Chile	1	170	170.00
Switzerland	1	105	105.00	Finland	1	163	163.00
Thailand	1	74	74.00	France	1	162	162.00
Turkey	1	71	71.00	-	-	-	-
Total	100	18038	4758.2	**Total**	**100**	**25277**	**5061.3**

The calculation of the publication of articles from countries is only based on the affiliation that published the articles. Table 4 shows that there are country differences between the top 100 digital learning papers and the top 100 mobile learning papers. For digital learning, it shows that there are 24 different countries that have produced the top 100. The United States dominates the production of papers with (33) articles, followed by the United Kingdom (13), Taiwan (7), China and the Netherlands respectively (5), Australia, Belgium, Finland, and Hong Kong (4), respectively, Canada, Germany, and South Korea (3), and France, Greece, Italy, New Zealand, Norway, Oman, Russia, Singapore, Spain, Switzerland, and Thailand each (1) article for digital learning. As for mobile learning, it shows that there are 23 different countries that have produced the top 100 articles. Article publications are dominated by Taiwan (26), United States (19), United Kingdom (17), Singapore (4), South Korea, Switzerland, Australia, China, and Japan respectively (3), Netherlands, Germany, Italy, Turkey, and Canada (2) each, and

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South Africa, Nigeria, Hong Kong, Malaysia, Spain, Portugal, Chile, Finland, and France each (1) article for mobile learning.

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3.7 Top 10 Productive Countries

When analyzing we found the leading countries that have the most publications on digital learning and mobile learning. Each of the top three countries that have the most publications during 1991 to 2021 are the United States (1354 doc), United Kingdom (456 doc), and China (407 doc) for digital learning which can be seen in Figure 5a. As for mobile learning, the top three countries that have the most publications during 1991 to 2021 are China (1390 docs), United States (1359 docs), and United Kingdom (659 docs) which can be seen in Figure 5b.

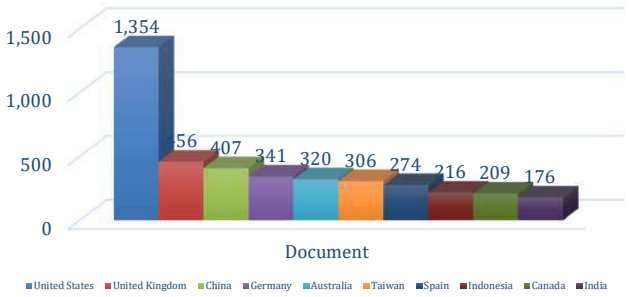

Figure 5a. Top 10 productive countries digital learning

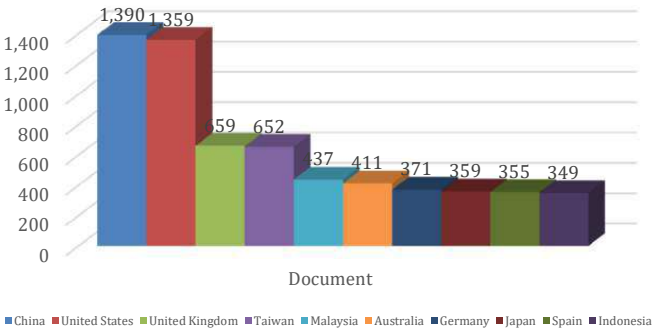

Figure 5b. Top 10 productive countries mobile learning

3.8 The differences and similarities between digital learning and mobile learning

After reviewing literature and other scientific sources, facts are obtained which state that there are so many differences and similarities between digital learning and mobile learning. That way, it is important to discuss this so that it can reduce misconceptions about digital learning and mobile learning. For more details presented in table.5

Table 5. Differences and similarities digital learning and mobile learning

Description	Digital Learning	Mobile Learning
Understanding	Digital learning is a digital learning resource that includes many elements to be used in learning [32]	Mobile learning is a learning model that adopts the development of mobile technology and mobile devices (HP) as a learning medium[33]
Function	Facilitates the learning process and presents more interesting teaching materials [32]	As an alternative to mobile or mobile-based learning services[34]
Forms/types of	• Blended learning • Online Learning/E-learning • Use of technology (applications, google, and the like) • Adaptive learning	• Applications • Web
Existence	continues to grow	Continuously develops
Devices	HP, notebook, Tablet, PDA, Computer, Web, PC, Tv, CD-ROM, and etc	Mobile, notebook, tablet, smartphone and PDAs.
Features	Video Streaming/live, virtual whiteboards, quizzes/virtual exams, discussion threads, online questionnaires, online TV, and etc [35]	Features that can be used Based on the type of application installed [36]
Scope	Covers all bases digital	According to the specs of the device used
Approach	All media	Certain applications
Size	Flexible	According to device
Application	All applications	Limited applications
Place	Virtual Classroom online, teachers in class, and internet labs	Flexible learning (anywhere and anytime)
Access	Internet	Internet

Based on Table 5 shows the differences and similarities between digital learning and mobile learning. Lots of people say that digital learning and mobile learning are the same thing. Even though there are differences between the two things [38]. In addition,

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digital learning includes all what learning is contained in mobile learning. This is because learning that uses mobile learning must be in digital form, whether it be applications, e-books, web, and etc [34, 35, 36, 38]. However, digital learning has so many other devices such as computers, PCs, tablets, and etc [39]. While mobile learning is more dependent on applications, Google, and the web [36]. If illustrated, it will look like figure 6.

Figure 6. relationship illustration digital learning and mobile learning

3.9 The advantages and disadvantages of digital learning and mobile learning

The results of the study of literature and scientific sources related to the topic of digital learning and mobile learning obtained the fact that each of them has advantages and disadvantages in each field. For more details, see Table 6 below.

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Table 6. Advantages and disadvantages of digital learning and mobile learning.

Digital Learning	Mobile Learning
Advantages	
• Relatively expensive according to the device used • Learning depends on the device used (for example, a computer should not be used while traveling while a tablet can be used anywhere) • Can eliminate some formal learning and make it more interesting • Types of wireless communication to access all information • Multiple delivery and content creation options • Facilitates both individual and collaborative learning experiences • helps provide and support literacy, numeracy and language learning • Can increase self-confidence in education • Increase skills in using technology in learning activities	• Relatively inexpensive because it only uses certain • cellphones Learning can be done anywhere, anytime, and is personalized • Can eliminate some formal learning and make it more interesting • Types of wireless communication to access all information • Multiple delivery and content creation options • Facilitate learning experiences both individually and collaboratively • to help provide and support literacy, numeracy and language learning • Can increase self-confidence in education • Increase skills in using technology in learning activities • Can conduct discussions without having to meet • Can access teaching materials needed at any time and certainly more attractive

Digital Learning	Mobile Learning
• Can have discussions without having to meet • Can use teaching materials as needed • Support distance • learning that develops in everyday life • Learning can be followed by more students	• Easier to carry and use • Supports distance learning Take • advantage of emerging technologies in everyday life • Learning can be followed by more students
Disadvantages	
• Can only be used use by people who can afford • It Always need internet access • Quickly makes you bored because you don't see each other • Practical learning can't be done maximally • Depends on a good network • Development and learning is more about knowledge • Can't monitor students individually • Learning depends on device battery percentage • Abstract learning is very difficult to understand • The atmosphere must be conducive • Requires a lot of help tools such as, Pen Tab, webcam, a good headset.	• Can only be used by people who can afford • It always requires internet access • Limited with storage from the device used • Large practicum applications cannot be installed • Depends on a good network • Development and learning is more about knowledge • Cannot monitor students individually • Learning depends on HP battery percentage • Many mobile differences such as iOS, Android, and Apple that can only be used on certain cell phones • Atmosphere must be conducive • Small memory capacity • Small screen view

Based on Table 6 shows the advantages and disadvantages of digital learning and mobile learning. Digital learning and mobile learning are learning alternatives that are growing rapidly in line with technological developments. In addition, the COVID-19 pandemic is still ongoing so that learning is shifted to online. There are advantages and disadvantages to each of the learning carried out as written in table 4. Actually digital learning has been popularized since 1960 by the University of Illinois with the aim only to convey information to students. However, along with the development of technology, digital learning continues to grow rapidly so that it is often used in learning including e-books, e-modul, PPT,and etc [32][43]. In this way, new innovations such as e-learning, blended learning, and mobile learning emerge.

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4 Conclusion

Digital learning and mobile learning are two different things but still have something in common. Learning with mobile learning is an innovation from digital learning. Based on Scopus data from 1992 to 2021, digital learning and mobile learning publications have on average experienced a significant increase. This is due to following technological developments and due to the ongoing COVID-19 pandemic. Based on the results

that have been presented, it can be seen the trends, differences, similarities, advantages, and disadvantages of digital learning and mobile learning. Thus, it is hoped that this discovery can be a reference for future discoveries in aspects of digital-based learning.

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Top 100 Cited Publications for The Last Thirty Years in Digital Learning and Mobile Learning

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Abstract—Digital learning and mobile learning are two different things but have something in common. This research aims to find trends, topics, similarities, differences, advantages, and disadvantages of digital learning and mobile learning over the last thirty years (1992 – 2021). The method used in this research is bibliometric analysis with the help of Ms-excel, VOSViewer, and Wordcloud to visualize the metadata obtained from Scopus. The findings show that the trend of digital learning continues to increase from year to year. In addition, it can explain that mobile learning is an innovative part of digital learning with almost the same differences, similarities, advantages, and disadvantages. In the future, it is hoped that further research related to digital learning will continue to develop along with technological developments.

Keywords—Bibliometric, digital learning, mobile learning, VOSViewer

1 Introduction

Education is so important for humans because it is one of the paths to success regardless of origin. This is evidenced by learning and development of knowledge from time to time continues to grow [1][2]. This is compounded by the existence of new policies that continue to change from year to year. There are so many changes that occur in the world of education [3][4]. According to [5][6], education is very important to continue to be developed in order to provide learning opportunities for all groups. In addition, education is included in the world leader's action plan known as the SDGs (Sustainable Development Goals) [7][8]. Major changes occurred during the Covid-19 pandemic. This causes learning to switch from offline (direct) to online (virtual) [9][10]. That way, new innovations and terms have emerged, such as learning platforms, learning applications, digital learning, online learning, web learning, e-modules, e-books, and many more. Several studies have been conducted regarding online learning models including mobile learning, the effectiveness of digital technology, digital readiness, digital comics, and usability of mobile learning apps [11][12][13][14][15].

Digital learning and mobile learning are the main topics of discussion in the world of education today [16][17]. This will certainly continue to grow along with technological developments. However, it is necessary to know about these developments through research that has been carried out by various authors and institutions by looking at the publications of previous studies to date in the form of conference proceedings, journal articles and other scientific media [18][19]. According to Yeaung et.al [20] , to see the most impactful topics is not easy to access. Therefore, there is a need for bibliometric analysis to identify and explore impactful topics [14][21]. Using bibliometric analysis can provide a valid review quality, visualize salient areas, improve understanding of

the distribution of a research topic, and provide clues for future research [22][23][24]. In addition, bibliometric analysis is assisted by using the VOSViewer, MS-Excel, and Word cloud software in visualizing the research results to make it more interesting.

The purpose of this study is to conduct a literature review related to digital learning and mobile learning topics for one hundred cited in the last thirty years from 1992 to 2021 using bibliometric analysis. There are several research questions were asked to help achieve the specific research problem:

1) What are the trends of publication from 1992 to 2021 in digital learning and mobile learning?
2) What are the types of publication of the top one hundred cited papers in digital learning and mobile learning?
3) How is the distribution of the top 100 papers quoted from digital learning and mobile learning?
4) Who are the prolific authors of the top one hundred cited papers in digital learning and mobile learning?
5) Which countries are most interested in digital learning research and mobile learning?
6) What are the differences and similarities between digital learning and mobile learning?
7) What are the advantages and disadvantages of digital learning and mobile learning?

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2 Methodology

This research is a type of quantitative research based on the Scopus database. Then, using bibliometric analysis that can prove and find novelty and trends in research [25][26][27][28]. Data collection was obtained through a Scopus search as of 23 January 2022 with the following criteria;

Table 1. Screening data

Description	Digital Learning	Mobile Learning
Keywords	Title (digital AND earning)	Title (mobile AND learning)
Document All Year	6255 Document	9542 document
Document year (1992-2021)	6148 Document	9481 document

Then the metadata is saved in csv format. and risk. After that, further analysis was carried out using software such as MS-Excel, VOSViewer, and WordCloud to make the data display more attractive [25][29][30]. According to Putri et al. [21] the effectiveness of VOSViewer has been proven in a recent study that has been carried out with the Scopus index.

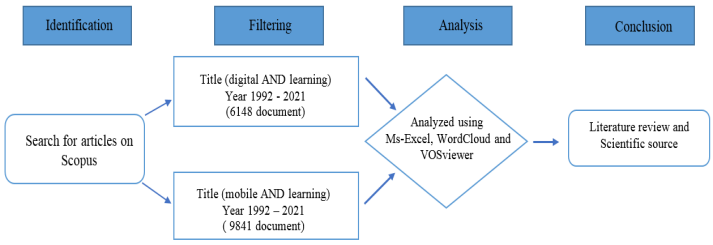
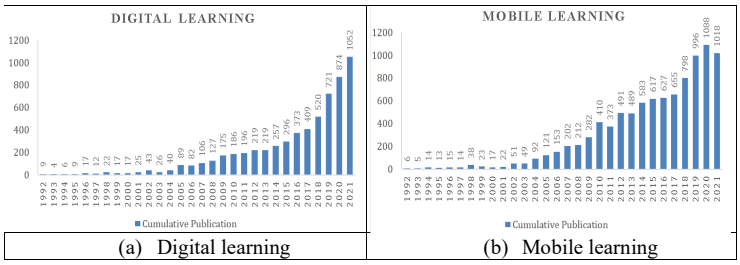


Figure 1. Flowchart research

3 Result and Discussion

3.1 Publication research trend

Figures 1a and 1b show a very significant development in the publication of articles on Scopus over the last thirty years. This shows that the high interest of the academic community towards research and the trends that are developing are very high.



(a) Digital learning (b) Mobile learning

Figure 2. Publication trend digital learning and mobile learning last thirty years

Figure 2 shows the number of articles in the field of digital learning and mobile learning at Scopus. Digital learning in 1992 only amounted to 9 documents. Then the increase occurred continuously which finally in 2021 the published articles had reached thousands, namely 1052 documents. Whereas mobile learning in 1992 only amounted to 6 documents. Then the increase occurred continuously which finally in 2021 the published articles had reached thousands, namely 1018 documents.

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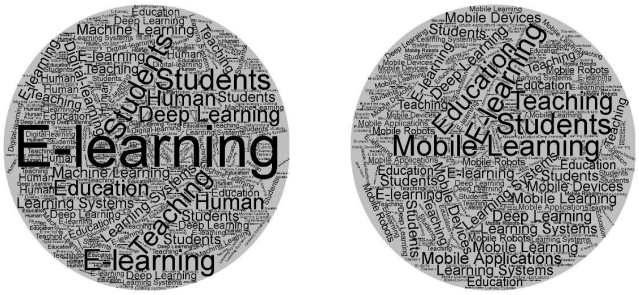
3.2 Visualization keyword of papers

The most frequently used keywords are graphically shown in Figure 3. Larger font sizes represent the frequency with which words are used the most. Words that are commonly used in digital learning are E-learning, students, human, teach, deep learning, etc. As for mobile learning, the words that are often used are mobile learning, students, E-learning, teaching, mobile application, education, etc.



(a) Digital Learning (b) Mobile Learning

Figure 3. The most relevant keywords

From 1992 to 2021 there were 6148 Scopus indexed documents with the topic of digital learning. As for the topic of mobile learning from 1992 to 2021, there are 9481 documents. Then the researcher visualized the trend of the topic with the help of VOSViewer which is presented in Figures 3a and 3b. In addition, the brightest color indicates the most updated word related to the BDAG [37].

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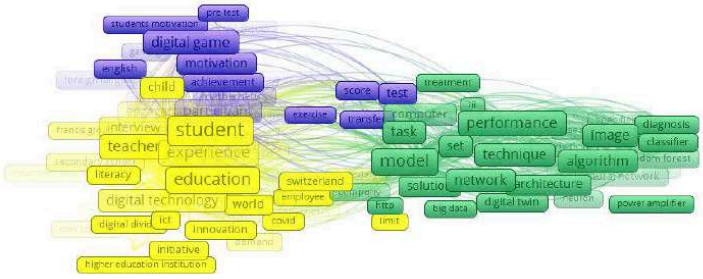

Figure 3a. The network visualization relevance trend in digital learning

Based on Figure 4(a) the relevance trend in digital learning produces three visible color clusters (yellow, green, and purple). In the first cluster (yellow color) are student, education, limit, initiative, higher education institution, innovation, ict, covid, world, digital technology, employee, switzerland, literacy, teacher, experience, interview, and etc. The second cluster (green color) is model, http, big data, solution, task, computer,

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treatment, set, performance, technique, network, digital twin, architecture, algorithm, image, power amplifier, classifier, diagnosis, and etc. The third cluster (purple color) is test, transfer, exercise, score, achievement, motivation, digital game, english, pre test, students motivation, and etc. In addition, the lightest color indicates the most updated word related to the topics [37].

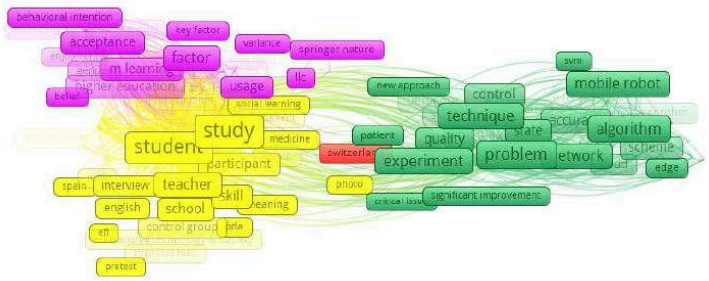

Figure 4b. The network visualization relevance trend in mobile learning

Based on Figure 4(b) the relevance trend in digital learning resulted in four visible color clusters (yellow, green, purple, and red). In the first cluster (yellow color) are study, student, participant, teacher, skill, learning, school, pretest, english, spain, interview, control group, social learning, medicine, photo, and etc. The second cluster (green) is problem, critical issue, significant improvement, experiment, patient, quality, technique, new approach, control, state, network, algorithm, mobile robot, edge, and etc. The third cluster (purple) is usage, ilc, springer nature, variance, factor, key factor, m-learning, belief, higher education, acceptance, behavioral intention, and etc. Cluster four (red) is Switzerland.

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3.3 Publication Type

Table 2. Document type of top cited paper

Document Type	Frequency		Total Cited		Mean		Median		SD	
	DL	ML	DL	ML	DL	ML	DL	ML	DL	ML
Article	80	82	13544*	21680*	169.3	264.4	119.0	212.5	158.8	132.8
Conference Paper	8	11	872	2637	109.0	239.7	92.0	229.0	45.9	65.7
Book	6	2	905	666	150.5	333.0	129.0	333.0	61.8	79.2
Review	4	4	758	1363	189.0*	340.8*	204.0*	339.5*	95.7	103.2
Book Chapter	1	1	88	299	88.0	299.0	88.0	299.0		-
Editorial	1	-	363	-	363.0	-	363.0	-	-	-
Total	**100**	**100**	**16530**	**26647**	**1069.6**	**1477.9**	**-**	**-**	**-**	**-**
*=the highest number										

Document types from the top 100 papers published in digital learning and mobile learning from 1992 to 2021 can be seen in Table 2. The 100 papers for digital learning has six document types, namely, articles (80), Conference paper (8), Book (6), Review (4), Book Chapter (1), and Editorial (1). In addition, the highest and lowest average number of review citations are (363.0) and (88.0) respectively, with the highest standard deviation (158.8). Meanwhile, for 100 mobile learning papers, there are five types of documents, namely articles (82), conference papers (11), books (2), reviews (4), and book chapters (1). Furthermore, for the highest and lowest average number of review citations, respectively (340.0) and (239.0) with the highest standard deviation (132.8).

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3.4 Distribution of Top Cited 100 Paper

Table 2. Distribution paper

Digital Learning						Mobile Learning					
Year	**Paper**	**Citation**	**ACPP**	**HAPPY**	**City Year**	**Year**	**Paper**	**Citation**	**ACPP**	**HAPPY**	**Citable**
1992	1	95	95.0	3.2	30	1995	1	202	202.0	7.5	27
1995	2	215	107.5	4.0	27	1996	1	222	222.0	8.5	26
2001	2	414	207.0	9.9	21	1998	2	903	451.5	18.8	24
2004	2	450	225.0	12.5	18	2000	1	601	601.0*	27.3	22
2005	4	1219	304.8	17.9	17	2002	4	872	218.0	10.9	20
2006	2	261	130.5	8.2	16	2003	6	1368	228.0	12.0	19
2007	5	878	175.6	11.7	15	2004	2	471	235.5	13.1	18
2008	5	844	168.8	12.1	14	2005	2	614	307.0	18.1	17
2009	7	2253	321.9*	24.8	13	2006	1	160	160.0	10.0	16
2010	3	410	136.7	11.4	12	2007	8	2170	271.3	18.1	15
2011	7	904	129.1	11.7	11	2008	6	2364	394.0	28.1	14
2012	10	1298	129.8	13.0	10	2009	10*	2856*	285.6	22.0	13
2013	7	1159	165.6	18.4	9	2010	8	1923	240.4	20.0	12
2014	8	860	107.5	13.4	8	2011	7	2328	332.6	30.2	11
2015	4	420	105.0	15.0	7	2012	5	1870	374.0	37.4	10
2016	11*	2433*	221.2	36.9	6	2013	5	1445	289.0	32.1	9
2017	4	5 33	133.3	26.7	5	2014	5	986	197.2	24.7	8
2018	6	807	134.5	33.6	4	2015	2	390	195.0	27.9	7
2019	8	711	88.9	29.6	3	2016	8	2211	276.4	46.1	6
2020	2	274	137.0	68.5*	2	2017	7	1510	215.7	43.1	5
-	-	-	-	-	-	2018	4	774	193.5	48.4	4
-	-	-	-	-	-	2019	4	1181	295.3	98.4*	3
-	-	-	-	-	-	2020	1	225	225.0	112.5	2
Total	100	16438	3224.5	382.3		Total	100	27646	6409.8	715.2	
ACPP= Average Citation Per Paper , ACPPY= Average Citation Per Paper Per Year, *= the highest number											

Based on the Table 2 above, for digital learning and mobile learning, publications do not occur every year. This can be seen in the years that have no paper at all. Furthermore, the top 100 articles on digital learning obtained a total of citations (16438) with an average of (3224.5) citations. The highest citation is (2433) in 2016, the highest average citation is (321.9) in 2009, and the highest average citation per paper per year is (68.5) in 2020. As for mobile learning, it gets a total of citations (27646) with an average (6409.8) citations. The highest citation is (2856) in 2009, the highest average citation is (601.0) in 2000, and the highest average citation per paper per year is (98.4) in 2019.

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3.5 Top 10 Authors with more articles

Table 3. Top 10 author with more article

Digital Learning			Mobile Learning		
Author	**Document**	**Country**	**Author**	**Document**	**Country**
Ifenthaler, D	15	Curtin University (Australia)	Hwang, GJ	70	National Taiwan University of Science and Technology (Taiwan)
Lam, EY	14	The University of Hong Kong (Hong Kong)	Huang, YM	39	National Cheng Kung University (Taiwan)
Chen, GD	13	National Central University(Taiwan)	Milrad, M	36	Linnaeus University (Sweden)
Barber, W.	12	Ontario Tech University (Canada)	Kukulska-Hulme, A	34	The Open University, Milton Keynes (United Kingdom)
Hwang, GJ	12	National Taiwan University of Science and Technology (Taiwan)	Wong, LH	34	National Institute of Education (Singapore)
Bandung, Y	11	Bandung Institute of Technology (Indonesia)	Traxler, J	30	University of Wolverhampton (United Kingdom)
Lee, JS	11	The Education University of Hong Kong (Hong Kong)	Looi, CK	29	Center for Research and Development in Learning (Singapore)
Erstad, O	9	Universitetet I Oslo (Norway)	Parsons, D	26	The Mind Lab, Auckland (New Zealand)
Huang, YM	9	National Cheng Kung University (Taiwan)	Sharples, M	26	The Open University, Milton Keynes (United Kingdom)
Sampson, DG	9	University of Piraeus (Greece)	Specht, M	24	Delft University of Technology (Netherlands)

Table 3 shows the top 10 authors' articles with the highest number of documents from 1992 to 2021 from different countries. In digital learning, it is dominated by Ifenthaler, D from Curtin University (Australia) with a total of 15 documents, followed by Lam, EY from The University of Hong Kong (Hong Kong) with a total of 14 documents, and followed by Chen, G.D from National Central University(Taiwan) with the number of diemen (13). Meanwhile, for mobile learning, it was dominated by Hwang, GJ from the National Taiwan University of Science and Technology (Taiwan) with a total of (70) documents, followed by Huang, YM from National Cheng Kung University (Taiwan) with 39 documents, and followed by Milrad, M from Linnaeus University (Sweden) with the number of documents (36).

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3.6 Top Country of Publication 100 Highest

Table 4. Top countries 100 cited publication (1992-2021)

Digital Learning				Mobile Learning			
Country	**Article**	**Total Citation**	**Average Article Citation**	**Country**	**Article**	**Total Citation**	**Average Article Citation**
United States	33	6452	195.52	Taiwan	26	8308	319.54
United Kingdom	13	2120	163.08	United States	19	5658	297.79
Taiwan	7	584	83.43	United Kingdom	17	3166	186.24
China	5	435	87.00	Singapore	4	879	219.75
Netherlands	5	1532	306.40	South Korea	3	744	248.00
Australia	4	490	122.50	Switzerland	3	831	277.00
Belgium	4	423	105.75	Australia	3	646	215.33
Finland	4	598	149.50	China	3	626	208.67
Hong Kong	4	548	137.00	Japan	3	622	207.33
Canada	3	1187	395.67	Netherlands	2	373	186.50
Germany	3	475	158.33	Germany	2	400	200.00
South Korea	3	510	170.00	Italy	2	382	191.00
France	1	295	295.00	Turkey	2	353	176.50
Greece	1	984	984.00	Canada	2	400	200.00
Italy	1	74	74.00	South Africa	1	303	303.00
New Zealand	1	137	137.00	Nigeria	1	300	300.00
Norway	1	81	81.00	Hong Kong	1	285	285.00
Oman	1	292	292.00	Malaysia	1	213	213.00
Russian	1	77	77.00	Spain	1	196	196.00
Singapore	1	189	189.00	Portugal	1	180	180.00
Spain	1	305	305.00	Chile	1	170	170.00
Switzerland	1	105	105.00	Finland	1	163	163.00
Thailand	1	74	74.00	France	1	162	162.00
Turkey	1	71	71.00	-	-	-	-
Total	100	18038	4758.2	**Total**	**100**	**25277**	**5061.3**

The calculation of the publication of articles from countries is only based on the affiliation that published the articles. Table 4 shows that there are country differences between the top 100 digital learning papers and the top 100 mobile learning papers. For digital learning, it shows that there are 24 different countries that have produced the top 100. The United States dominates the production of papers with (33) articles, followed by the United Kingdom (13), Taiwan (7), China and the Netherlands respectively (5), Australia, Belgium, Finland, and Hong Kong (4), respectively, Canada, Germany, and South Korea (3), and France, Greece, Italy, New Zealand, Norway, Oman, Russia, Singapore, Spain, Switzerland, and Thailand each (1) article for digital learning. As for mobile learning, it shows that there are 23 different countries that have produced the top 100 articles. Article publications are dominated by Taiwan (26), United States (19), United Kingdom (17), Singapore (4), South Korea, Switzerland, Australia, China, and Japan respectively (3), Netherlands, Germany, Italy, Turkey, and Canada (2) each, and

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South Africa, Nigeria, Hong Kong, Malaysia, Spain, Portugal, Chile, Finland, and France each (1) article for mobile learning.

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3.7 Top 10 Productive Countries

When analyzing we found the leading countries that have the most publications on digital learning and mobile learning. Each of the top three countries that have the most publications during 1991 to 2021 are the United States (1354 doc), United Kingdom (456 doc), and China (407 doc) for digital learning which can be seen in Figure 5a. As for mobile learning, the top three countries that have the most publications during 1991 to 2021 are China (1390 docs), United States (1359 docs), and United Kingdom (659 docs) which can be seen in Figure 5b.

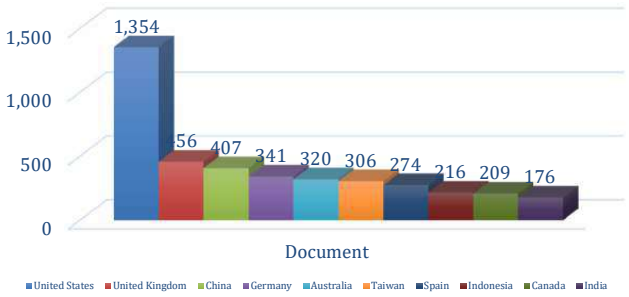

Figure 5a. Top 10 productive countries digital learning

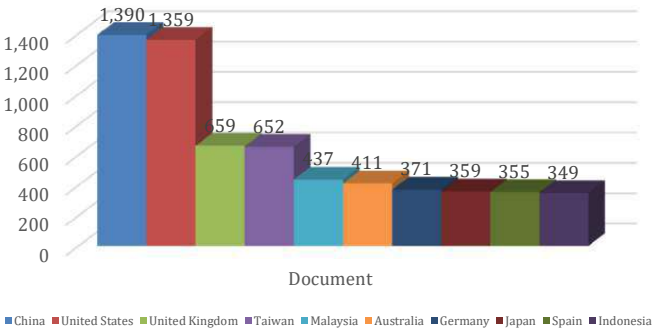

Figure 5b. Top 10 productive countries mobile learning

3.8 The differences and similarities between digital learning and mobile learning

After reviewing literature and other scientific sources, facts are obtained which state that there are so many differences and similarities between digital learning and mobile learning. That way, it is important to discuss this so that it can reduce misconceptions about digital learning and mobile learning. For more details presented in table.5

Table 5. Differences and similarities digital learning and mobile learning

Description	Digital Learning	Mobile Learning
Understanding	Digital learning is a digital learning resource that includes many elements to be used in learning [32]	Mobile learning is a learning model that adopts the development of mobile technology and mobile devices (HP) as a learning medium[33]
Function	Facilitates the learning process and presents more interesting teaching materials [32]	As an alternative to mobile or mobile-based learning services[34]
Forms/types of	• Blended learning • Online Learning/E-learning • Use of technology (applications, google, and the like) • Adaptive learning	• Applications • Web
Existence	continues to grow	Continuously develops
Devices	HP, notebook, Tablet, PDA, Computer, Web, PC, Tv, CD-ROM, and etc	Mobile, notebook, tablet, smartphone and PDAs.
Features	Video Streaming/live, virtual whiteboards, quizzes/virtual exams, discussion threads, online questionnaires, online TV, and etc [35]	Features that can be used Based on the type of application installed [36]
Scope	Covers all bases digital	According to the specs of the device used
Approach	All media	Certain applications
Size	Flexible	According to device
Application	All applications	Limited applications
Place	Virtual Classroom online, teachers in class, and internet labs	Flexible learning (anywhere and anytime)
Access	Internet	Internet

Based on Table 5 shows the differences and similarities between digital learning and mobile learning. Lots of people say that digital learning and mobile learning are the same thing. Even though there are differences between the two things [38]. In addition,

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digital learning includes all what learning is contained in mobile learning. This is because learning that uses mobile learning must be in digital form, whether it be applications, e-books, web, and etc [34, 35, 36, 38]. However, digital learning has so many other devices such as computers, PCs, tablets, and etc [39]. While mobile learning is more dependent on applications, Google, and the web [36]. If illustrated, it will look like figure 6.

Figure 6. relationship illustration digital learning and mobile learning

3.9 The advantages and disadvantages of digital learning and mobile learning

The results of the study of literature and scientific sources related to the topic of digital learning and mobile learning obtained the fact that each of them has advantages and disadvantages in each field. For more details, see Table 6.

Table 6. Advantages and disadvantages of digital learning and mobile learning.

Digital Learning	Mobile Learning
Advantages	
● Relatively expensive according to the device used ● Learning depends on the device used (for example, a computer should not be used while traveling while a tablet can be used anywhere) ● Can eliminate some formal learning and make it more interesting ● Types of wireless communication to access all information ● Multiple delivery and content creation options ● Facilitates both individual and collaborative learning experiences ● helps provide and support literacy, numeracy and language learning ● Can increase self-confidence in education ● Increase skills in using technology in learning activities	● Relatively inexpensive because it only uses certain ● cellphones Learning can be done anywhere, anytime, and is personalized ● Can eliminate some formal learning and make it more interesting ● Types of wireless communication to access all information ● Multiple delivery and content creation options ● Facilitate learning experiences both individually and collaboratively ● to help provide and support literacy, numeracy and language learning ● Can increase self-confidence in education ● Increase skills in using technology in learning activities ● Can conduct discussions without having to meet

Digital Learning	Mobile Learning
• Can have discussions without having to meet • Can use teaching materials as needed • Support distance • learning that develops in everyday life • Learning can be followed by more students	• Can access teaching materials needed at any time and certainly more attractive • Easier to carry and use • Supports distance learning Take • advantage of emerging technologies in everyday life • Learning can be followed by more students
Disadvantages	
• Can only be used use by people who can afford • It Always need internet access • Quickly makes you bored because you don't see each other • Practical learning can't be done maximally • Depends on a good network • Development and learning is more about knowledge • Can't monitor students individually • Learning depends on device battery percentage • Abstract learning is very difficult to understand • The atmosphere must be conducive • Requires a lot of help tools such as, Pen Tab, webcam, a good headset.	• Can only be used by people who can afford • It always requires internet access • Limited with storage from the device used • Large practicum applications cannot be installed • Depends on a good network • Development and learning is more about knowledge • Cannot monitor students individually • Learning depends on HP battery percentage • Many mobile differences such as iOS, Android, and Apple that can only be used on certain cell phones • Atmosphere must be conducive • Small memory capacity • Small screen view

Based on Table 6 shows the advantages and disadvantages of digital learning and mobile learning. Digital learning and mobile learning are learning alternatives that are growing rapidly in line with technological developments. In addition, the COVID-19 pandemic is still ongoing so that learning is shifted to online. There are advantages and disadvantages to each of the learning carried out as written in table 4. Actually digital learning has been popularized since 1960 by the University of Illinois with the aim only to convey information to students. However, along with the development of technology, digital learning continues to grow rapidly so that it is often used in learning including e-books, e-modul, PPT,and etc [32][43]. In this way, new innovations such as e-learning, blended learning, and mobile learning emerge.

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Add the research implication

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4 Conclusion

Digital learning and mobile learning are two different things but still have something in common. Learning with mobile learning is an innovation from digital learning. Based on Scopus data from 1992 to 2021, digital learning and mobile learning publications

have on average experienced a significant increase. This is due to following technological developments and due to the ongoing COVID-19 pandemic. Based on the results that have been presented, it can be seen the trends, differences, similarities, advantages, and disadvantages of digital learning and mobile learning. Thus, it is hoped that this discovery can be a reference for future discoveries in aspects of digital-based learning.

5 Acknowledgment

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Top 100 Cited Publications for The Last Thirty Years in Digital Learning and Mobile Learning

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Abstract—Digital learning and mobile learning are two different things but have something in common. This research aims to find trends, topics, similarities, differences, advantages, and disadvantages of digital learning and mobile learning over the last thirty years (1992 – 2021). The method used in this research is bibliometric analysis with the help of Ms-excel, VOSViewer, and Wordcloud to visualize the metadata obtained from Scopus. The findings show that the trend of digital learning continues to increase from year to year. In addition, it can explain that mobile learning is an innovative part of digital learning with almost the same differences, similarities, advantages, and disadvantages. In the future, it is hoped that further research related to digital learning will continue to develop along with technological developments.

Keywords—Bibliometric, digital learning, mobile learning, VOSViewer

1 Introduction

Education is so important for humans because it is one of the paths to success regardless of origin. This is evidenced by learning and development of knowledge from time to time continues to grow [1][2]. This is compounded by the existence of new policies that continue to change from year to year. There are so many changes that occur in the world of education [3][4]. According to [5][6], education is very important to continue to be developed in order to provide learning opportunities for all groups. In addition, education is included in the world leader's action plan known as the SDGs (Sustainable Development Goals) [7][8]. Major changes occurred during the Covid-19 pandemic. This causes learning to switch from offline (direct) to online (virtual) [9][10]. That way, new innovations and terms have emerged, such as learning platforms, learning applications, digital learning, online learning, web learning, e-modules, e-books, and many more. Several studies have been conducted regarding online learning models including mobile learning, the effectiveness of digital technology, digital readiness, digital comics, and usability of mobile learning apps [11][12][13][14][15].

Digital learning and mobile learning are the main topics of discussion in the world of education today [16][17]. This will certainly continue to grow along with technological developments. However, it is necessary to know about these developments through

research that has been carried out by various authors and institutions by looking at the publications of previous studies to date in the form of conference proceedings, journal articles and other scientific media [18][19]. According to Yeaung et.al [20] , to see the most impactful topics is not easy to access. Therefore, there is a need for bibliometric analysis to identify and explore impactful topics [14][21]. Using bibliometric analysis can provide a valid review quality, visualize salient areas, improve understanding of the distribution of a research topic, and provide clues for future research [22][23][24]. In addition, bibliometric analysis is assisted by using the VOSViewer, MS-Excel, and Word cloud software in visualizing the research results to make it more interesting.

The purpose of this study is to conduct a literature review related to digital learning and mobile learning topics for one hundred cited in the last thirty years from 1992 to 2021 using bibliometric analysis. There are several research questions were asked to help achieve the specific research problem:

1) What are the trends of publication from 1992 to 2021 in digital learning and mobile learning?
2) What are the types of publication of the top one hundred cited papers in digital learning and mobile learning?
3) How is the distribution of the top 100 papers quoted from digital learning and mobile learning?
4) Who are the prolific authors of the top one hundred cited papers in digital learning and mobile learning?
5) Which countries are most interested in digital learning research and mobile learning?
6) What are the differences and similarities between digital learning and mobile learning?
7) What are the advantages and disadvantages of digital learning and mobile learning?

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2 Methodology

This research is a type of quantitative research based on the Scopus database. Then, using bibliometric analysis that can prove and find novelty and trends in research [25][26][27][28]. Data collection was obtained through a Scopus search as of 23 January 2022 with the following criteria;

Table 1. Screening data

Description	Digital Learning	Mobile Learning
Keywords	Title (digital AND earning)	Title (mobile AND learning)
Document All Year	6255 Document	9542 document
Document year (1992-2021)	6148 Document	9481 document

Then the metadata is saved in csv format. and risk. After that, further analysis was carried out using software such as MS-Excel, VOSViewer, and WordCloud to make

the data display more attractive [25][29][30]. According to Putri et al. [21] the effectiveness of VOSViewer has been proven in a recent study that has been carried out with the Scopus index.

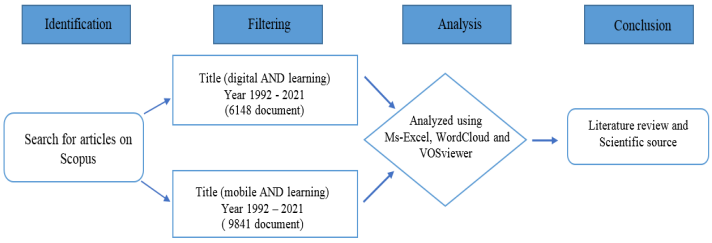
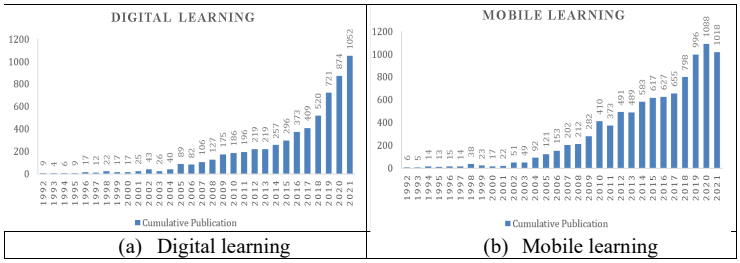


Figure 1. Flowchart research

3 Result and Discussion

3.1 Publication research trend

Figures 1a and 1b show a very significant development in the publication of articles on Scopus over the last thirty years. This shows that the high interest of the academic community towards research and the trends that are developing are very high.



(a) Digital learning (b) Mobile learning

Figure 2. Publication trend digital learning and mobile learning last thirty years

Figure 2 shows the number of articles in the field of digital learning and mobile learning at Scopus. Digital learning in 1992 only amounted to 9 documents. Then the increase occurred continuously which finally in 2021 the published articles had reached thousands, namely 1052 documents. Whereas mobile learning in 1992 only amounted to 6 documents. Then the increase occurred continuously which finally in 2021 the published articles had reached thousands, namely 1018 documents.

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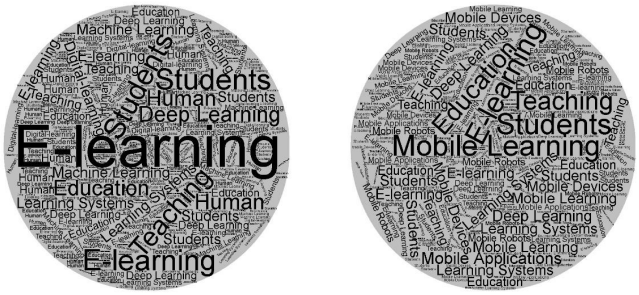
3.2 Visualization keyword of papers

The most frequently used keywords are graphically shown in Figure 3. Larger font sizes represent the frequency with which words are used the most. Words that are commonly used in digital learning are E-learning, students, human, teach, deep learning, etc. As for mobile learning, the words that are often used are mobile learning, students, E-learning, teaching, mobile application, education, etc.



(a) Digital Learning (b) Mobile Learning

Figure 3. The most relevant keywords

From 1992 to 2021 there were 6148 Scopus indexed documents with the topic of digital learning. As for the topic of mobile learning from 1992 to 2021, there are 9481 documents. Then the researcher visualized the trend of the topic with the help of VOSViewer which is presented in Figures 3a and 3b. In addition, the brightest color indicates the most updated word related to the BDAG [37].

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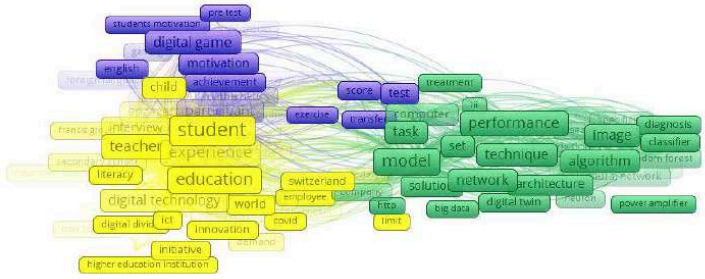

Figure 3a. The network visualization relevance trend in digital learning

Based on Figure 4(a) the relevance trend in digital learning produces three visible color clusters (yellow, green, and purple). In the first cluster (yellow color) are student, education, limit, initiative, higher education institution, innovation, ict, covid, world, digital technology, employee, switzerland, literacy, teacher, experience, interview, and etc. The second cluster (green color) is model, http, big data, solution, task, computer,

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treatment, set, performance, technique, network, digital twin, architecture, algorithm, image, power amplifier, classifier, diagnosis, and etc. The third cluster (purple color) is test, transfer, exercise, score, achievement, motivation, digital game, english, pre test, students motivation, and etc. In addition, the lightest color indicates the most updated word related to the topics [37].

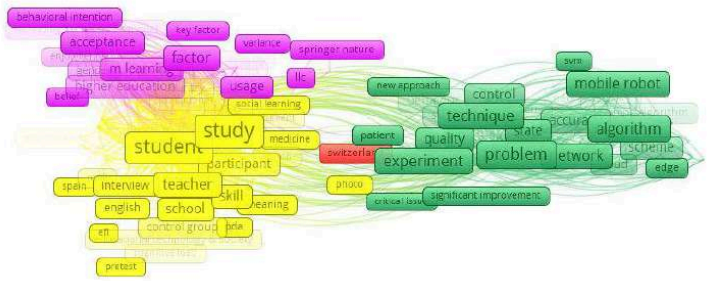

Figure 4b. The network visualization relevance trend in mobile learning

Based on Figure 4(b) the relevance trend in digital learning resulted in four visible color clusters (yellow, green, purple, and red). In the first cluster (yellow color) are study, student, participant, teacher, skill, learning, school, pretest, english, spain, interview, control group, social learning, medicine, photo, and etc. The second cluster (green) is problem, critical issue, significant improvement, experiment, patient, quality, technique, new approach, control, state, network, algorithm, mobile robot, edge, and etc. The third cluster (purple) is usage, ilc, springer nature, variance, factor, key factor, m-learning, belief, higher education, acceptance, behavioral intention, and etc. Cluster four (red) is Switzerland.

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3.3 Publication Type

Table 2. Document type of top cited paper

Document Type	Frequency		Total Cited		Mean		Median		SD	
	DL	ML	DL	ML	DL	ML	DL	ML	DL	ML
Article	80	82	13544*	21680*	169.3	264.4	119.0	212.5	158.8	132.8
Conference Paper	8	11	872	2637	109.0	239.7	92.0	229.0	45.9	65.7
Book	6	2	905	666	150.5	333.0	129.0	333.0	61.8	79.2
Review	4	4	758	1363	189.0*	340.8*	204.0*	339.5*	95.7	103.2
Book Chapter	1	1	88	299	88.0	299.0	88.0	299.0		-
Editorial	1	-	363	-	363.0	-	363.0	-	-	-
Total	**100**	**100**	**16530**	**26647**	**1069.6**	**1477.9**	**-**	**-**	**-**	**-**
*=the highest number										

Document types from the top 100 papers published in digital learning and mobile learning from 1992 to 2021 can be seen in Table 2. The 100 papers for digital learning has six document types, namely, articles (80), Conference paper (8), Book (6), Review (4), Book Chapter (1), and Editorial (1). In addition, the highest and lowest average number of review citations are (363.0) and (88.0) respectively, with the highest standard deviation (158.8). Meanwhile, for 100 mobile learning papers, there are five types of documents, namely articles (82), conference papers (11), books (2), reviews (4), and book chapters (1). Furthermore, for the highest and lowest average number of review citations, respectively (340.0) and (239.0) with the highest standard deviation (132.8).

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3.4 Distribution of Top Cited 100 Paper

Table 2. Distribution paper

Digital Learning						Mobile Learning					
Year	**Paper**	**Citation**	**ACPP**	**HAPPY**	**City Year**	**Year**	**Paper**	**Citation**	**ACPP**	**HAPPY**	**Citable**
1992	1	95	95.0	3.2	30	1995	1	202	202.0	7.5	27
1995	2	215	107.5	4.0	27	1996	1	222	222.0	8.5	26
2001	2	414	207.0	9.9	21	1998	2	903	451.5	18.8	24
2004	2	450	225.0	12.5	18	2000	1	601	601.0*	27.3	22
2005	4	1219	304.8	17.9	17	2002	4	872	218.0	10.9	20
2006	2	261	130.5	8.2	16	2003	6	1368	228.0	12.0	19
2007	5	878	175.6	11.7	15	2004	2	471	235.5	13.1	18
2008	5	844	168.8	12.1	14	2005	2	614	307.0	18.1	17
2009	7	2253	321.9*	24.8	13	2006	1	160	160.0	10.0	16
2010	3	410	136.7	11.4	12	2007	8	2170	271.3	18.1	15
2011	7	904	129.1	11.7	11	2008	6	2364	394.0	28.1	14
2012	10	1298	129.8	13.0	10	2009	10*	2856*	285.6	22.0	13
2013	7	1159	165.6	18.4	9	2010	8	1923	240.4	20.0	12
2014	8	860	107.5	13.4	8	2011	7	2328	332.6	30.2	11
2015	4	420	105.0	15.0	7	2012	5	1870	374.0	37.4	10
2016	11*	2433*	221.2	36.9	6	2013	5	1445	289.0	32.1	9
2017	4	5 33	133.3	26.7	5	2014	5	986	197.2	24.7	8
2018	6	807	134.5	33.6	4	2015	2	390	195.0	27.9	7
2019	8	711	88.9	29.6	3	2016	8	2211	276.4	46.1	6
2020	2	274	137.0	68.5*	2	2017	7	1510	215.7	43.1	5
-	-	-	-	-	-	2018	4	774	193.5	48.4	4
-	-	-	-	-	-	2019	4	1181	295.3	98.4*	3
-	-	-	-	-	-	2020	1	225	225.0	112.5	2
Total	100	16438	3224.5	382.3		Total	100	27646	6409.8	715.2	
ACPP= Average Citation Per Paper , ACPPY= Average Citation Per Paper Per Year, *= the highest number											

Based on the Table 2 above, for digital learning and mobile learning, publications do not occur every year. This can be seen in the years that have no paper at all. Furthermore, the top 100 articles on digital learning obtained a total of citations (16438) with an average of (3224.5) citations. The highest citation is (2433) in 2016, the highest average citation is (321.9) in 2009, and the highest average citation per paper per year is (68.5) in 2020. As for mobile learning, it gets a total of citations (27646) with an average (6409.8) citations. The highest citation is (2856) in 2009, the highest average citation is (601.0) in 2000, and the highest average citation per paper per year is (98.4) in 2019.

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3.5 Top 10 Authors with more articles

Table 3. Top 10 author with more article

Digital Learning			Mobile Learning		
Author	**Document**	**Country**	**Author**	**Document**	**Country**
Ifenthaler, D	15	Curtin University (Australia)	Hwang, GJ	70	National Taiwan University of Science and Technology (Taiwan)
Lam, EY	14	The University of Hong Kong (Hong Kong)	Huang, YM	39	National Cheng Kung University (Taiwan)
Chen, GD	13	National Central University(Taiwan)	Milrad, M	36	Linnaeus University (Sweden)
Barber, W.	12	Ontario Tech University (Canada)	Kukulska-Hulme, A	34	The Open University, Milton Keynes (United Kingdom)
Hwang, GJ	12	National Taiwan University of Science and Technology (Taiwan)	Wong, LH	34	National Institute of Education (Singapore)
Bandung, Y	11	Bandung Institute of Technology (Indonesia)	Traxler, J	30	University of Wolverhampton (United Kingdom)
Lee, JS	11	The Education University of Hong Kong (Hong Kong)	Looi, CK	29	Center for Research and Development in Learning (Singapore)
Erstad, O	9	Universitetet I Oslo (Norway)	Parsons, D	26	The Mind Lab, Auckland (New Zealand)
Huang, YM	9	National Cheng Kung University (Taiwan)	Sharples, M	26	The Open University, Milton Keynes (United Kingdom)
Sampson, DG	9	University of Piraeus (Greece)	Specht, M	24	Delft University of Technology (Netherlands)

Table 3 shows the top 10 authors' articles with the highest number of documents from 1992 to 2021 from different countries. In digital learning, it is dominated by Ifenthaler, D from Curtin University (Australia) with a total of 15 documents, followed by Lam, EY from The University of Hong Kong (Hong Kong) with a total of 14 documents, and followed by Chen, G.D from National Central University(Taiwan) with the number of diemen (13). Meanwhile, for mobile learning, it was dominated by Hwang, GJ from the National Taiwan University of Science and Technology (Taiwan) with a total of (70) documents, followed by Huang, YM from National Cheng Kung University (Taiwan) with 39 documents, and followed by Milrad, M from Linnaeus University (Sweden) with the number of documents (36).

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3.6 Top Country of Publication 100 Highest

Table 4. Top countries 100 cited publication (1992-2021)

Digital Learning				Mobile Learning			
Country	**Article**	**Total Citation**	**Average Article Citation**	**Country**	**Article**	**Total Citation**	**Average Article Citation**
United States	33	6452	195.52	Taiwan	26	8308	319.54
United Kingdom	13	2120	163.08	United States	19	5658	297.79
Taiwan	7	584	83.43	United Kingdom	17	3166	186.24
China	5	435	87.00	Singapore	4	879	219.75
Netherlands	5	1532	306.40	South Korea	3	744	248.00
Australia	4	490	122.50	Switzerland	3	831	277.00
Belgium	4	423	105.75	Australia	3	646	215.33
Finland	4	598	149.50	China	3	626	208.67
Hong Kong	4	548	137.00	Japan	3	622	207.33
Canada	3	1187	395.67	Netherlands	2	373	186.50
Germany	3	475	158.33	Germany	2	400	200.00
South Korea	3	510	170.00	Italy	2	382	191.00
France	1	295	295.00	Turkey	2	353	176.50
Greece	1	984	984.00	Canada	2	400	200.00
Italy	1	74	74.00	South Africa	1	303	303.00
New Zealand	1	137	137.00	Nigeria	1	300	300.00
Norway	1	81	81.00	Hong Kong	1	285	285.00
Oman	1	292	292.00	Malaysia	1	213	213.00
Russian	1	77	77.00	Spain	1	196	196.00
Singapore	1	189	189.00	Portugal	1	180	180.00
Spain	1	305	305.00	Chile	1	170	170.00
Switzerland	1	105	105.00	Finland	1	163	163.00
Thailand	1	74	74.00	France	1	162	162.00
Turkey	1	71	71.00	-	-	-	-
Total	100	18038	4758.2	**Total**	**100**	**25277**	**5061.3**

The calculation of the publication of articles from countries is only based on the affiliation that published the articles. Table 4 shows that there are country differences between the top 100 digital learning papers and the top 100 mobile learning papers. For digital learning, it shows that there are 24 different countries that have produced the top 100. The United States dominates the production of papers with (33) articles, followed by the United Kingdom (13), Taiwan (7), China and the Netherlands respectively (5), Australia, Belgium, Finland, and Hong Kong (4), respectively, Canada, Germany, and South Korea (3), and France, Greece, Italy, New Zealand, Norway, Oman, Russia, Singapore, Spain, Switzerland, and Thailand each (1) article for digital learning. As for mobile learning, it shows that there are 23 different countries that have produced the top 100 articles. Article publications are dominated by Taiwan (26), United States (19), United Kingdom (17), Singapore (4), South Korea, Switzerland, Australia, China, and Japan respectively (3), Netherlands, Germany, Italy, Turkey, and Canada (2) each, and

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South Africa, Nigeria, Hong Kong, Malaysia, Spain, Portugal, Chile, Finland, and France each (1) article for mobile learning.

3.7 Top 10 Productive Countries

When analyzing we found the leading countries that have the most publications on digital learning and mobile learning. Each of the top three countries that have the most publications during 1991 to 2021 are the United States (1354 doc), United Kingdom (456 doc), and China (407 doc) for digital learning which can be seen in Figure 5a. As for mobile learning, the top three countries that have the most publications during 1991 to 2021 are China (1390 docs), United States (1359 docs), and United Kingdom (659 docs) which can be seen in Figure 5b.

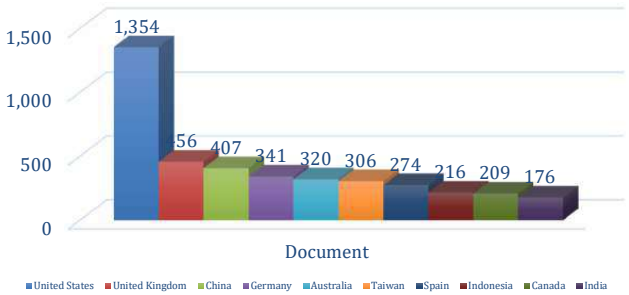

Figure 5a. Top 10 productive countries digital learning

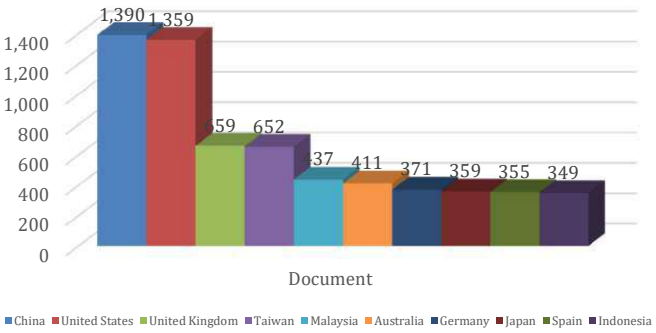

Figure 5b. Top 10 productive countries mobile learning

3.8 The differences and similarities between digital learning and mobile learning

After reviewing literature and other scientific sources, facts are obtained which state that there are so many differences and similarities between digital learning and mobile learning. That way, it is important to discuss this so that it can reduce misconceptions about digital learning and mobile learning. For more details presented in table.5

Table 5. Differences and similarities digital learning and mobile learning

Description	Digital Learning	Mobile Learning
Understanding	Digital learning is a digital learning resource that includes many elements to be used in learning [32]	Mobile learning is a learning model that adopts the development of mobile technology and mobile devices (HP) as a learning medium[33]
Function	Facilitates the learning process and presents more interesting teaching materials [32]	As an alternative to mobile or mobile-based learning services[34]
Forms/types of	• Blended learning • Online Learning/E-learning • Use of technology (applications, google, and the like) • Adaptive learning	• Applications • Web
Existence	continues to grow	Continuously develops
Devices	HP, notebook, Tablet, PDA, Computer, Web, PC, Tv, CD-ROM, and etc	Mobile, notebook, tablet, smartphone and PDAs.
Features	Video Streaming/live, virtual whiteboards, quizzes/virtual exams, discussion threads, online questionnaires, online TV, and etc [35]	Features that can be used Based on the type of application installed [36]
Scope	Covers all bases digital	According to the specs of the device used
Approach	All media	Certain applications
Size	Flexible	According to device
Application	All applications	Limited applications
Place	Virtual Classroom online, teachers in class, and internet labs	Flexible learning (anywhere and anytime)
Access	Internet	Internet

Based on Table 5 shows the differences and similarities between digital learning and mobile learning. Lots of people say that digital learning and mobile learning are the same thing. Even though there are differences between the two things [38]. In addition,

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digital learning includes all what learning is contained in mobile learning. This is because learning that uses mobile learning must be in digital form, whether it be applications, e-books, web, and etc [34, 35, 36, 38]. However, digital learning has so many other devices such as computers, PCs, tablets, and etc [39]. While mobile learning is more dependent on applications, Google, and the web [36]. If illustrated, it will look like figure 6.

Figure 6. relationship illustration digital learning and mobile learning

3.9 The advantages and disadvantages of digital learning and mobile learning

The results of the study of literature and scientific sources related to the topic of digital learning and mobile learning obtained the fact that each of them has advantages and disadvantages in each field. For more details, see Table 6.

Table 6. Advantages and disadvantages of digital learning and mobile learning.

Digital Learning	Mobile Learning
Advantages	
● Relatively expensive according to the device used ● Learning depends on the device used (for example, a computer should not be used while traveling while a tablet can be used anywhere) ● Can eliminate some formal learning and make it more interesting ● Types of wireless communication to access all information ● Multiple delivery and content creation options ● Facilitates both individual and collaborative learning experiences ● helps provide and support literacy, numeracy and language learning ● Can increase self-confidence in education ● Increase skills in using technology in learning activities	● Relatively inexpensive because it only uses certain ● cellphones Learning can be done anywhere, anytime, and is personalized ● Can eliminate some formal learning and make it more interesting ● Types of wireless communication to access all information ● Multiple delivery and content creation options ● Facilitate learning experiences both individually and collaboratively ● to help provide and support literacy, numeracy and language learning ● Can increase self-confidence in education ● Increase skills in using technology in learning activities ● Can conduct discussions without having to meet ● Can access teaching materials needed at any time and certainly more attractive

Digital Learning	Mobile Learning
• Can have discussions without having to meet • Can use teaching materials as needed • Support distance • learning that develops in everyday life • Learning can be followed by more students	• Easier to carry and use • Supports distance learning Take • advantage of emerging technologies in everyday life • Learning can be followed by more students
Disadvantages	
• Can only be used use by people who can afford • It Always need internet access • Quickly makes you bored because you don't see each other • Practical learning can't be done maximally • Depends on a good network • Development and learning is more about knowledge • Can't monitor students individually • Learning depends on device battery percentage • Abstract learning is very difficult to understand • The atmosphere must be conducive • Requires a lot of help tools such as, Pen Tab, webcam, a good headset.	• Can only be used by people who can afford • It always requires internet access • Limited with storage from the device used • Large practicum applications cannot be installed • Depends on a good network • Development and learning is more about knowledge • Cannot monitor students individually • Learning depends on HP battery percentage • Many mobile differences such as iOS, Android, and Apple that can only be used on certain cell phones • Atmosphere must be conducive • Small memory capacity • Small screen view

Based on Table 6 shows the advantages and disadvantages of digital learning and mobile learning. Digital learning and mobile learning are learning alternatives that are growing rapidly in line with technological developments. In addition, the COVID-19 pandemic is still ongoing so that learning is shifted to online. There are advantages and disadvantages to each of the learning carried out as written in table 4. Actually digital learning has been popularized since 1960 by the University of Illinois with the aim only to convey information to students. However, along with the development of technology, digital learning continues to grow rapidly so that it is often used in learning including e-books, e-modul, PPT,and etc [32][43]. In this way, new innovations such as e-learning, blended learning, and mobile learning emerge.

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Add the research implication

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3.10 Research Implication:

- To Researcher, can be the basis for further research in the field of digital-based implementation which has similarities but is in fact different. In addition, you can find out trends in digital-based learning that are in accordance with certain conditions, both nationally and internationally.

- To Librarian, can be a source of new research and knowledge related to the development of digital-based learning in an increasingly advanced era with technology
- To Policymakers, can provide sources of information on digital research topics that are growing rapidly so that they can make decisions with certain considerations based on valid information obtained.

4 Conclusion

Digital learning and mobile learning are two different things but still have something in common. Learning with mobile learning is an innovation from digital learning. Based on Scopus data from 1992 to 2021, digital learning and mobile learning publications have on average experienced a significant increase. This is due to following technological developments and due to the ongoing COVID-19 pandemic. Based on the results that have been presented, it can be seen the trends, differences, similarities, advantages, and disadvantages of digital learning and mobile learning. Thus, it is hoped that this discovery can be a reference for future discoveries in aspects of digital-based learning.

5 Acknowledgment

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Top 100 Cited Publications for The Last Thirty Years in Digital Learning and Mobile Learning

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Abstract—Digital learning and mobile learning are two different things but have something in common. This research aims to find trends, topics, similarities, differences, advantages, and disadvantages of digital learning and mobile learning over the last thirty years (1992 – 2021). The method used in this research is bibliometric analysis with the help of Ms-excel, VOSViewer, and Wordcloud to visualize the metadata obtained from Scopus. The findings show that the trend of digital learning continues to increase from year to year. In addition, it can explain that mobile learning is an innovative part of digital learning with almost the same differences, similarities, advantages, and disadvantages. In the future, it is hoped that further research related to digital learning will continue to develop along with technological developments.

Keywords—Bibliometric, digital learning, mobile learning, VOSViewer

1 Introduction

Education is so important for humans because it is one of the paths to success regardless of origin. This is evidenced by learning and development of knowledge from time to time continues to grow [1][2]. This is compounded by the existence of new policies that continue to change from year to year. There are so many changes that occur in the world of education [3][4]. According to [5][6], education is very important to continue to be developed in order to provide learning opportunities for all groups. In addition, education is included in the world leader's action plan known as the SDGs (Sustainable Development Goals) [7][8]. Major changes occurred during the Covid-19 pandemic. This causes learning to switch from offline (direct) to online (virtual) [9][10]. That way, new innovations and terms have emerged, such as learning platforms, learning applications, digital learning, online learning, web learning, e-modules, e-books, and many more. Several studies have been conducted regarding online learning models including mobile learning, the effectiveness of digital technology, digital readiness, digital comics, and usability of mobile learning apps [11][12][13][14][15].

Digital learning and mobile learning are the main topics of discussion in the world of education today [16][17]. This will certainly continue to grow along with technological developments. However, it is necessary to know about these developments through

research that has been carried out by various authors and institutions by looking at the publications of previous studies to date in the form of conference proceedings, journal articles and other scientific media [18][19]. According to Yeaung et.al [20] . to see the most impactful topics is not easy to access. Therefore, there is a need for bibliometric analysis to identify and explore impactful topics [14][21]. Using bibliometric analysis can provide a valid review quality, visualize salient areas, improve understanding of the distribution of a research topic, and provide clues for future research [22][23][24]. In addition, bibliometric analysis is assisted by using the VOSViewer, MS-Excel, and Word cloud software in visualizing the research results to make it more interesting.

The purpose of this study is to conduct a literature review related to digital learning and mobile learning topics for one hundred cited in the last thirty years from 1992 to 2021 using bibliometric analysis. There are several research questions were asked to help achieve the specific research problem:

1) What are the trends of publication from 1992 to 2021 in digital learning and mobile learning?
2) What are the types of publication of the top one hundred cited papers in digital learning and mobile learning?
3) How is the distribution of the top 100 papers quoted from digital learning and mobile learning?
4) Who are the prolific authors of the top one hundred cited papers in digital learning and mobile learning?
5) Which countries are most interested in digital learning research and mobile learning?
6) What are the differences and similarities between digital learning and mobile learning?
7) What are the advantages and disadvantages of digital learning and mobile learning?

2 Methodology

This research is a type of quantitative research based on the Scopus database. Then, using bibliometric analysis that can prove and find novelty and trends in research [25][26][27][28]. Data collection was obtained through a Scopus search as of 23 January 2022 with the following criteria;

Table 1. Screening data

Description	Digital Learning	Mobile Learning
Keywords	Title (digital AND earning)	Title (mobile AND learning)
Document All Year	6255 Document	9542 document
Document year (1992-2021)	6148 Document	9481 document

Then the metadata is saved in csv format. and risk. After that, further analysis was carried out using software such as MS-Excel, VOSViewer, and WordCloud to make

the data display more attractive [25][29][30]. According to Putri et al. [21] the effectiveness of VOSViewer has been proven in a recent study that has been carried out with the Scopus index.

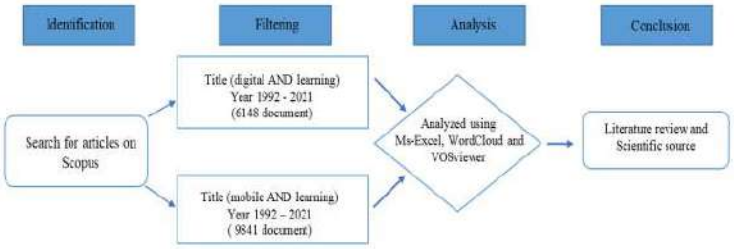
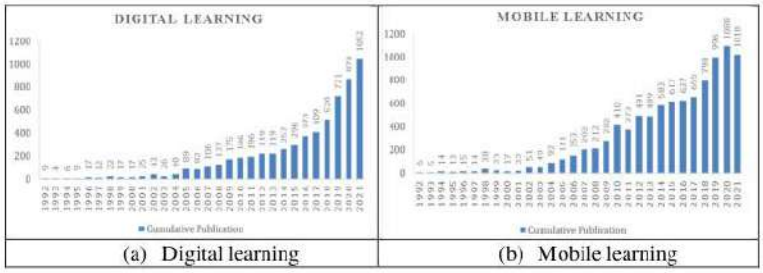


Figure 1. Flowchart research

3 Result and Discussion

3.1 Publication research trend

Figures 1a and 1b show a very significant development in the publication of articles on Scopus over the last thirty years. This shows that the high interest of the academic community towards research and the trends that are developing are very high.



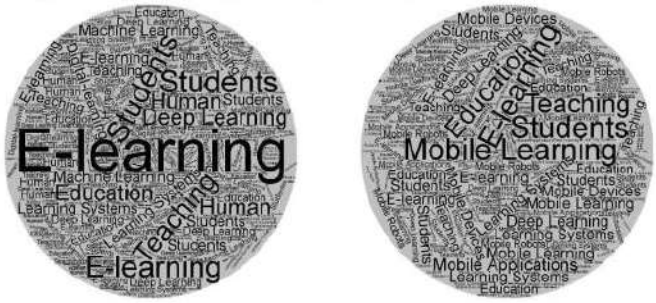
(a) Digital learning (b) Mobile learning

Figure 2. Publication trend digital learning and mobile learning last thirty years

Figure 2 shows the number of articles in the field of digital learning and mobile learning at Scopus. Digital learning in 1992 only amounted to 9 documents. Then the increase occurred continuously which finally in 2021 the published articles had reached thousands, namely 1052 documents. Whereas mobile learning in 1992 only amounted to 6 documents. Then the increase occurred continuously which finally in 2021 the published articles had reached thousands, namely 1018 documents.

3.2 Visualization keyword of papers

The most frequently used keywords are graphically shown in Figure 3. Larger font sizes represent the frequency with which words are used the most. Words that are commonly used in digital learning are E-learning, students, human, teach, deep learning, etc. As for mobile learning, the words that are often used are mobile learning, students, E-learning, teaching, mobile application, education, etc.



(a) Digital Learning (b) Mobile Learning

Figure 3. The most relevant keywords

From 1992 to 2021 there were 6148 Scopus indexed documents with the topic of digital learning. As for the topic of mobile learning from 1992 to 2021, there are 9481 documents. Then the researcher visualized the trend of the topic with the help of VOSViewer which is presented in Figures 3a and 3b. In addition, the brightest color indicates the most updated word related to the BDAG [37].

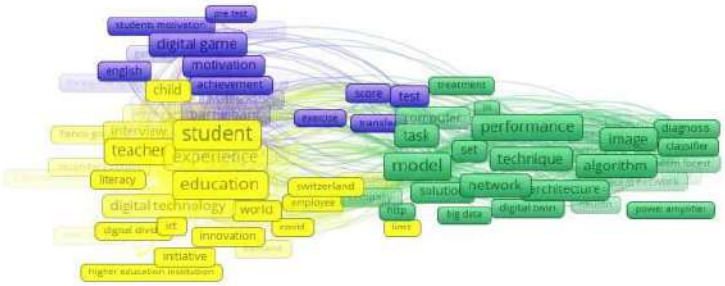


Figure 3a. The network visualization relevance trend in digital learning

Based on Figure 4(a) the relevance trend in digital learning produces three visible color clusters (yellow, green, and purple). In the first cluster (yellow color) are student, education, limit, initiative, higher education institution, innovation, ict, covid, world, digital technology, employee, switzerland, literacy, teacher, experience, interview, and etc. The second cluster (green color) is model, http, big data, solution, task, computer,

treatment, set, performance, technique, network, digital twin, architecture, algorithm, image, power amplifier, classifier, diagnosis, and etc. The third cluster (purple color) is test, transfer, exercise, score, achievement, motivation, digital game, english, pre test, students motivation, and etc. In addition, the lightest color indicates the most updated word related to the topics [37].

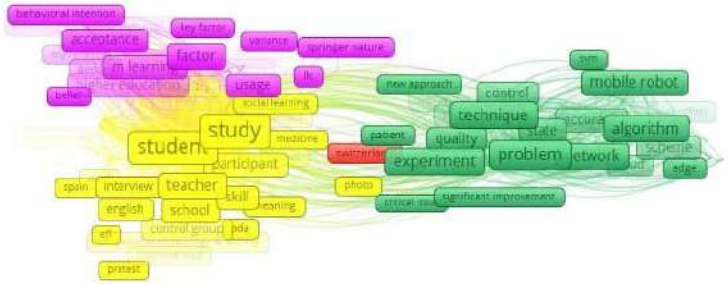


Figure 4b. The network visualization relevance trend in mobile learning

Based on Figure 4(b) the relevance trend in digital learning resulted in four visible color clusters (yellow, green, purple, and red). In the first cluster (yellow color) are study, student, participant, teacher, skill, learning, school, pretest, english, spain, interview, control group, social learning, medicine, photo, and etc. The second cluster (green) is problem, critical issue, significant improvement, experiment, patient, quality, technique, new approach, control, state, network, algorithm, mobile robot, edge, and etc. The third cluster (purple) is usage, ilc, springer nature, variance, factor, key factor, m-learning, belief, higher education, acceptance, behavioral intention, and etc. Cluster four (red) is Switzerland.

3.3 Publication Type

Table 2. Document type of top cited paper

Document Type	Frequency		Total Cited		Mean		Median		SD	
	DL	ML	DL	ML	DL	ML	DL	ML	DL	ML
Article	80	82	13544*	21680*	169.3	264.4	119.0	212.5	158.8	132.8
Conference Paper	8	11	872	2637	109.0	239.7	92.0	229.0	45.9	65.7
Book	6	2	905	666	150.5	333.0	129.0	333.0	61.8	79.2
Review	4	4	758	1363	189.0*	340.8*	204.0*	339.5*	95.7	103.2
Book Chapter	1	1	88	299	88.0	299.0	88.0	299.0		-
Editorial	1	-	363	-	363.0	-	363.0	-	-	-
Total	**100**	**100**	**16530**	**26647**	**1069.6**	**1477.9**	**-**	**-**	**-**	**-**

*=the highest number

Document types from the top 100 papers published in digital learning and mobile learning from 1992 to 2021 can be seen in Table 2. The 100 papers for digital learning has six document types, namely, articles (80), Conference paper (8), Book (6), Review (4), Book Chapter (1), and Editorial (1). In addition, the highest and lowest average number of review citations are (363.0) and (88.0) respectively, with the highest standard deviation (158.8). Meanwhile, for 100 mobile learning papers, there are five types of documents, namely articles (82), conference papers (11), books (2), reviews (4), and book chapters (1). Furthermore, for the highest and lowest average number of review citations, respectively (340.0) and (239.0) with the highest standard deviation (132.8).

3.4 Distribution of Top Cited 100 Paper

Table 2. Distribution paper

Digital Learning						Mobile Learning					
Year	Paper	Citation	ACPP	HAPPY	City Year	Year	Paper	Citation	ACPP	HAPPY	Citable
1992	1	95	95.0	3.2	30	1995	1	202	202.0	7.5	27
1995	2	215	107.5	4.0	27	1996	1	222	222.0	8.5	26
2001	2	414	207.0	9.9	21	1998	2	903	451.5	18.8	24
2004	2	450	225.0	12.5	18	2000	1	601	601.0*	27.3	22
2005	4	1219	304.8	17.9	17	2002	4	872	218.0	10.9	20
2006	2	261	130.5	8.2	16	2003	6	1368	228.0	12.0	19
2007	5	878	175.6	11.7	15	2004	2	471	235.5	13.1	18
2008	5	844	168.8	12.1	14	2005	2	614	307.0	18.1	17
2009	7	2253	321.9*	24.8	13	2006	1	160	160.0	10.0	16
2010	3	410	136.7	11.4	12	2007	8	2170	271.3	18.1	15
2011	7	904	129.1	11.7	11	2008	6	2364	394.0	28.1	14
2012	10	1298	129.8	13.0	10	2009	10*	2856*	285.6	22.0	13
2013	7	1159	165.6	18.4	9	2010	8	1923	240.4	20.0	12
2014	8	860	107.5	13.4	8	2011	7	2328	332.6	30.2	11
2015	4	420	105.0	15.0	7	2012	5	1870	374.0	37.4	10
2016	11*	2433*	221.2	36.9	6	2013	5	1445	289.0	32.1	9
2017	4	533	133.3	26.7	5	2014	5	986	197.2	24.7	8
2018	6	807	134.5	33.6	4	2015	2	390	195.0	27.9	7
2019	8	711	88.9	29.6	3	2016	8	2211	276.4	46.1	6
2020	2	274	137.0	68.5*	2	2017	7	1510	215.7	43.1	5
-	-	-	-	-	-	2018	4	774	193.5	48.4	4
-	-	-	-	-	-	2019	4	1181	295.3	98.4*	3
-	-	-	-	-	-	2020	1	225	225.0	112.5	2
Total	100	16438	3224.5	382.3		Total	100	27646	6409.8	715.2	

ACPP= Average Citation Per Paper , ACPPY= Average Citation Per Paper Per Year, *= the highest number

Based on the Table 2 above, for digital learning and mobile learning, publications do not occur every year. This can be seen in the years that have no paper at all. Furthermore, the top 100 articles on digital learning obtained a total of citations (16438) with an average of (3224.5) citations. The highest citation is (2433) in 2016, the highest average citation is (321.9) in 2009, and the highest average citation per paper per year is (68.5) in 2020. As for mobile learning, it gets a total of citations (27646) with an average (6409.8) citations. The highest citation is (2856) in 2009, the highest average citation is (601.0) in 2000, and the highest average citation per paper per year is (98.4) in 2019.

3.5 Top 10 Authors with more articles

Table 3. Top 10 author with more article

Digital Learning			Mobile Learning		
Author	**Document**	**Country**	**Author**	**Document**	**Country**
Ifenthaler, D	15	Curtin University (Australia)	Hwang, GJ	70	National Taiwan University of Science and Technology (Taiwan)
Lam, EY	14	The University of Hong Kong (Hong Kong)	Huang, YM	39	National Cheng Kung University (Taiwan)
Chen, GD	13	National Central University(Taiwan)	Milrad, M	36	Linnaeus University (Sweden)
Barber, W.	12	Ontario Tech University (Canada)	Kukulska-Hulme, A	34	The Open University, Milton Keynes (United Kingdom)
Hwang, GJ	12	National Taiwan University of Science and Technology (Taiwan)	Wong, LH	34	National Institute of Education (Singapore)
Bandung, Y	11	Bandung Institute of Technology (Indonesia)	Traxler, J	30	University of Wolverhampton (United Kingdom)
Lee, JS	11	The Education University of Hong Kong (Hong Kong)	Looi, CK	29	Center for Research and Development in Learning (Singapore)
Erstad, O	9	Universitetet I Oslo (Norway)	Parsons, D	26	The Mind Lab, Auckland (New Zealand)
Huang, YM	9	National Cheng Kung University (Taiwan)	Sharples, M	26	The Open University, Milton Keynes (United Kingdom)
Sampson, DG	9	University of Piraeus (Greece)	Specht, M	24	Delft University of Technology (Netherlands)

Table 3 shows the top 10 authors' articles with the highest number of documents from 1992 to 2021 from different countries. In digital learning, it is dominated by Ifenthaler, D from Curtin University (Australia) with a total of 15 documents, followed by Lam, EY from The University of Hong Kong (Hong Kong) with a total of 14 documents, and followed by Chen, G.D from National Central University(Taiwan) with the number of documents (13). Meanwhile, for mobile learning, it was dominated by Hwang, GJ from the National Taiwan University of Science and Technology (Taiwan) with a total of (70) documents, followed by Huang, YM from National Cheng Kung University (Taiwan) with 39 documents, and followed by Milrad, M from Linnaeus University (Sweden) with the number of documents (36).

3.6 Top Country of Publication 100 Highest

Table 4. Top countries 100 cited publication (1992-2021)

Digital Learning				Mobile Learning			
Country	**Article**	**Total Citation**	**Average Article Citation**	**Country**	**Article**	**Total Citation**	**Average Article Citation**
United States	33	6452	195.52	Taiwan	26	8308	319.54
United Kingdom	13	2120	163.08	United States	19	5658	297.79
Taiwan	7	584	83.43	United Kingdom	17	3166	186.24
China	5	435	87.00	Singapore	4	879	219.75
Netherlands	5	1532	306.40	South Korea	3	744	248.00
Australia	4	490	122.50	Switzerland	3	831	277.00
Belgium	4	423	105.75	Australia	3	646	215.33
Finland	4	598	149.50	China	3	626	208.67
Hong Kong	4	548	137.00	Japan	3	622	207.33
Canada	3	1187	395.67	Netherlands	2	373	186.50
Germany	3	475	158.33	Germany	2	400	200.00
South Korea	3	510	170.00	Italy	2	382	191.00
France	1	295	295.00	Turkey	2	353	176.50
Greece	1	984	984.00	Canada	2	400	200.00
Italy	1	74	74.00	South Africa	1	303	303.00
New Zealand	1	137	137.00	Nigeria	1	300	300.00
Norway	1	81	81.00	Hong Kong	1	285	285.00
Oman	1	292	292.00	Malaysia	1	213	213.00
Russian	1	77	77.00	Spain	1	196	196.00
Singapore	1	189	189.00	Portugal	1	180	180.00
Spain	1	305	305.00	Chile	1	170	170.00
Switzerland	1	105	105.00	Finland	1	163	163.00
Thailand	1	74	74.00	France	1	162	162.00
Turkey	1	71	71.00	-	-	-	-
Total	100	18038	4758.2	**Total**	**100**	**25277**	**5061.3**

The calculation of the publication of articles from countries is only based on the affiliation that published the articles. Table 4 shows that there are country differences between the top 100 digital learning papers and the top 100 mobile learning papers. For digital learning, it shows that there are 24 different countries that have produced the top 100. The United States dominates the production of papers with (33) articles, followed by the United Kingdom (13), Taiwan (7), China and the Netherlands respectively (5), Australia, Belgium, Finland, and Hong Kong (4), respectively, Canada, Germany, and South Korea (3), and France, Greece, Italy, New Zealand, Norway, Oman, Russia, Singapore, Spain, Switzerland, and Thailand each (1) article for digital learning. As for mobile learning, it shows that there are 23 different countries that have produced the top 100 articles. Article publications are dominated by Taiwan (26), United States (19), United Kingdom (17), Singapore (4), South Korea, Switzerland, Australia, China, and Japan respectively (3), Netherlands, Germany, Italy, Turkey, and Canada (2) each, and

South Africa, Nigeria, Hong Kong, Malaysia, Spain, Portugal, Chile, Finland, and France each (1) article for mobile learning.

3.7 Top 10 Productive Countries

When analyzing we found the leading countries that have the most publications on digital learning and mobile learning. Each of the top three countries that have the most publications during 1991 to 2021 are the United States (1354 doc), United Kingdom (456 doc), and China (407 doc) for digital learning which can be seen in Figure 5a. As for mobile learning, the top three countries that have the most publications during 1991 to 2021 are China (1390 docs), United States (1359 docs), and United Kingdom (659 docs) which can be seen in Figure 5b.

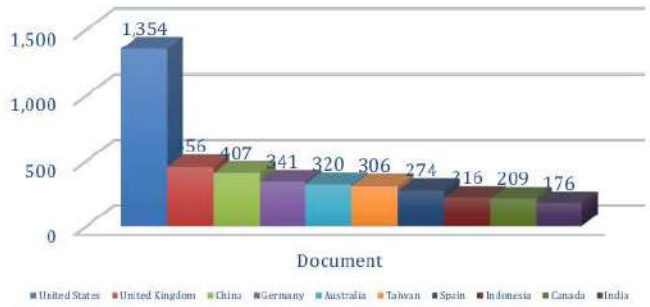


Figure 5a. Top 10 productive countries digital learning

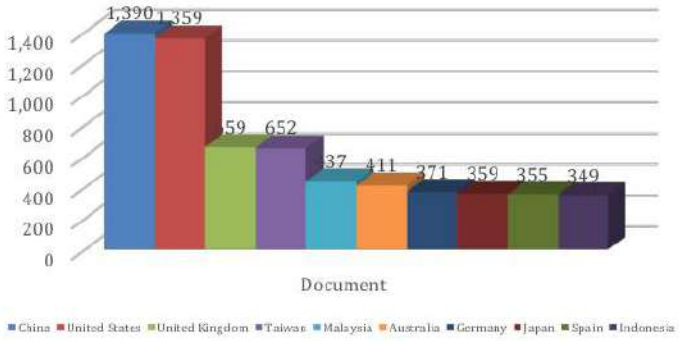


Figure 5b. Top 10 productive countries mobile learning

3.8 The differences and similarities between digital learning and mobile learning

After reviewing literature and other scientific sources, facts are obtained which state that there are so many differences and similarities between digital learning and mobile learning. That way, it is important to discuss this so that it can reduce misconceptions about digital learning and mobile learning. For more details presented in table.5

Table 5. Differences and similarities digital learning and mobile learning

Description	Digital Learning	Mobile Learning
Understanding	Digital learning is a digital learning resource that includes many elements to be used in learning [32]	Mobile learning is a learning model that adopts the development of mobile technology and mobile devices (HP) as a learning medium[33]
Function	Facilitates the learning process and presents more interesting teaching materials [32]	As an alternative to mobile or mobile-based learning services[34]
Forms/types of	• Blended learning • Online Learning/E-learning • Use of technology (applications, google, and the like) • Adaptive learning	• Applications • Web
Existence	continues to grow	Continuously develops
Devices	HP, notebook, Tablet, PDA, Computer, Web, PC, Tv, CD-ROM, and etc	Mobile, notebook, tablet, smartphone and PDAs.
Features	Video Streaming/live, virtual whiteboards, quizzes/virtual exams, discussion threads, online questionnaires, online TV, and etc [35]	Features that can be used Based on the type of application installed [36]
Scope	Covers all bases digital	According to the specs of the device used
Approach	All media	Certain applications
Size	Flexible	According to device
Application	All applications	Limited applications
Place	Virtual Classroom online, teachers in class, and internet labs	Flexible learning (anywhere and anytime)
Access	Internet	Internet

Based on Table 5 shows the differences and similarities between digital learning and mobile learning. Lots of people say that digital learning and mobile learning are the same thing. Even though there are differences between the two things [38]. In addition,

digital learning includes all what learning is contained in mobile learning. This is because learning that uses mobile learning must be in digital form, whether it be applications, e-books, web, and etc [34, 35, 36, 38]. However, digital learning has so many other devices such as computers, PCs, tablets, and etc [39]. While mobile learning is more dependent on applications, Google, and the web [36]. If illustrated, it will look like figure 6.

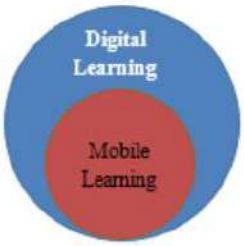


Figure 6. relationship illustration digital learning and mobile learning

3.9 The advantages and disadvantages of digital learning and mobile learning

The results of the study of literature and scientific sources related to the topic of digital learning and mobile learning obtained the fact that each of them has advantages and disadvantages in each field. For more detail see Table 6 below.

Table 6. Advantages and disadvantages of digital learning and mobile learning.

Digital Learning	Mobile Learning
Advantages	
• Relatively expensive according to the device used • Learning depends on the device used (for example, a computer should not be used while traveling while a tablet can be used anywhere) • Can eliminate some formal learning and make it more interesting • Types of wireless communication to access all information • Multiple delivery and content creation options • Facilitates both individual and collaborative learning experiences • helps provide and support literacy, numeracy and language learning • Can increase self-confidence in education • Increase skills in using technology in learning activities	• Relatively inexpensive because it only uses certain • cellphones Learning can be done anywhere, anytime, and is personalized • Can eliminate some formal learning and make it more interesting • Types of wireless communication to access all information • Multiple delivery and content creation options • Facilitate learning experiences both individually and collaboratively • to help provide and support literacy, numeracy and language learning • Can increase self-confidence in education • Increase skills in using technology in learning activities • Can conduct discussions without having to meet • Can access teaching materials needed at any time and certainly more attractive

Digital Learning	Mobile Learning
• Can have discussions without having to meet • Can use teaching materials as needed • Support distance • learning that develops in everyday life • Learning can be followed by more students	• Easier to carry and use • Supports distance learning Take • advantage of emerging technologies in everyday life • Learning can be followed by more students
Disadvantages	
• Can only be used use by people who can afford • It Always need internet access • Quickly makes you bored because you don't see each other • Practical learning can't be done maximally • Depends on a good network • Development and learning is more about knowledge • Can't monitor students individually • Learning depends on device battery percentage • Abstract learning is very difficult to understand • The atmosphere must be conducive • Requires a lot of help tools such as, Pen Tab, webcam, a good headset.	• Can only be used by people who can afford • It always requires internet access • Limited with storage from the device used • Large practicum applications cannot be installed • Depends on a good network • Development and learning is more about knowledge • Cannot monitor students individually • Learning depends on HP battery percentage • Many mobile differences such as iOS, Android, and Apple that can only be used on certain cell phones • Atmosphere must be conducive • Small memory capacity • Small screen view

Based on Table 6 shows the advantages and disadvantages of digital learning and mobile learning. Digital learning and mobile learning are learning alternatives that are growing rapidly in line with technological developments. In addition, the COVID-19 pandemic is still ongoing so that learning is shifted to online. There are advantages and disadvantages to each of the learning carried out as written in table 4. Actually digital learning has been popularized since 1960 by the University of Illinois with the aim only to convey information to students. However, along with the development of technology, digital learning continues to grow rapidly so that it is often used in learning including e-books, e-modul, PPT,and etc [32][43]. In this way, new innovations such as e-learning, blended learning, and mobile learning emerge.

3.10 Research Implication:

- To Researcher, can be the basis for further research in the field of digital-based implementation which has similarities but is in fact different. In addition, you can find out trends in digital-based learning that are in accordance with certain conditions, both nationally and internationally.

- To Librarian, can be a source of new research and knowledge related to the development of digital-based learning in an increasingly advanced era with technology
- To Policymakers, can provide sources of information on digital research topics that are growing rapidly so that they can make decisions with certain considerations based on valid information obtained.

4 Conclusion

Digital learning and mobile learning are two different things but still have something in common. Learning with mobile learning is an innovation from digital learning. Based on Scopus data from 1992 to 2021, digital learning and mobile learning publications have on average experienced a significant increase. This is due to following technological developments and due to the ongoing COVID-19 pandemic. Based on the results that have been presented, it can be seen the trends, differences, similarities, advantages, and disadvantages of digital learning and mobile learning. Thus, it is hoped that this discovery can be a reference for future discoveries in aspects of digital-based learning.

5 Acknowledgment

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All author are members from grant research and take part in the jobs.

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ORIGINALITY REPORT

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SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Miao, Guoxin. "The construction and development of university mobile learning system", 2013 6th International Conference on Information Management Innovation Management and Industrial Engineering, 2013. Publication	1%
2	Qiang, Pan. "Application of mobile learning in college students' learning", 2013 6th International Conference on Information Management Innovation Management and Industrial Engineering, 2013. Publication	<1%
3	www.mdpi.com Internet Source	<1%
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Top 100 Cited Publications for The Last Thirty Years in Digital Learning and Mobile Learning

https://doi.org/10.3991/ijim.vx.ix.xxxx

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Abstract—Digital learning and mobile learning are two different things but have something in common. This research aims to find trends, topics, similarities, differences, advantages, and disadvantages of digital learning and mobile learning over the last thirty years (1992 – 2021). The method used in this research is bibliometric analysis with the help of Ms-excel, VOSViewer, and Wordcloud to visualize the metadata obtained from Scopus. The findings show that the trend of digital learning continues to increase from year to year. In addition, it can explain that mobile learning is an innovative part of digital learning with almost the same differences, similarities, advantages, and disadvantages. In the future, it is hoped that further research related to digital learning will continue to develop along with technological developments.

Keywords—Bibliometric, digital learning, mobile learning, VOSViewer

1 Introduction

Education is so important for humans because it is one of the paths to success regardless of origin. This is evidenced by learning and development of knowledge from time to time continues to grow [1][2]. This is compounded by the existence of new policies that continue to change from year to year. There are so many changes that occur in the world of education [3][4]. According to [5][6], education is very important to continue to be developed in order to provide learning opportunities for all groups. In addition, education is included in the world leader's action plan known as the SDGs (Sustainable Development Goals) [7][8]. Major changes occurred during the Covid-19 pandemic. This causes learning to switch from offline (direct) to online (virtual) [9][10]. That way, new innovations and terms have emerged, such as learning platforms, learning applications, digital learning, online learning, web learning, e-modules, e-books, and many more. Several studies have been conducted regarding online learning models including mobile learning, the effectiveness of digital technology, digital readiness, digital comics, and usability of mobile learning apps [11][12][13][14][15].

Digital learning and mobile learning are the main topics of discussion in the world of education today [16][17]. This will certainly continue to grow along with technological developments. However, it is necessary to know about these developments through

research that has been carried out by various authors and institutions by looking at the publications of previous studies to date in the form of conference proceedings, journal articles and other scientific media [18][19]. According to Yeaung et.al [20] , to see the most impactful topics is not easy to access. Therefore, there is a need for bibliometric analysis to identify and explore impactful topics [14][21]. Using bibliometric analysis can provide a valid review quality, visualize salient areas, improve understanding of the distribution of a research topic, and provide clues for future research [22][23][24]. In addition, bibliometric analysis is assisted by using the VOSViewer, MS-Excel, and Word cloud software in visualizing the research results to make it more interesting.

The purpose of this study is to conduct a literature review related to digital learning and mobile learning topics for one hundred cited in the last thirty years from 1992 to 2021 using bibliometric analysis. There are several research questions were asked to help achieve the specific research problem:

1) What are the trends of publication from 1992 to 2021 in digital learning and mobile learning?
2) What are the types of publication of the top one hundred cited papers in digital learning and mobile learning?
3) How is the distribution of the top 100 papers quoted from digital learning and mobile learning?
4) Who are the prolific authors of the top one hundred cited papers in digital learning and mobile learning?
5) Which countries are most interested in digital learning research and mobile learning?
6) What are the differences and similarities between digital learning and mobile learning?
7) What are the advantages and disadvantages of digital learning and mobile learning?

2 Methodology

This research is a type of quantitative research based on the Scopus database. Then, using bibliometric analysis that can prove and find novelty and trends in research [25][26][27][28]. Data collection was obtained through a Scopus search as of 23 January 2022 with the following criteria;

Table 1. Screening data

Description	**Digital Learning**	**Mobile Learning**
Keywords	Title (digital AND earning)	Title (mobile AND learning)
Document All Year	6255 Document	9542 document
Document year (1992-2021)	6148 Document	9481 document

Then the metadata is saved in csv format. and risk. After that, further analysis was carried out using software such as MS-Excel, VOSViewer, and WordCloud to make

the data display more attractive [25][29][30]. According to Putri et al. [21] the effectiveness of VOSViewer has been proven in a recent study that has been carried out with the Scopus index.

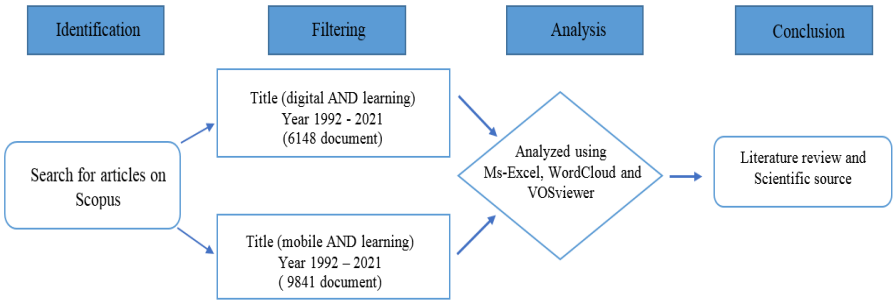
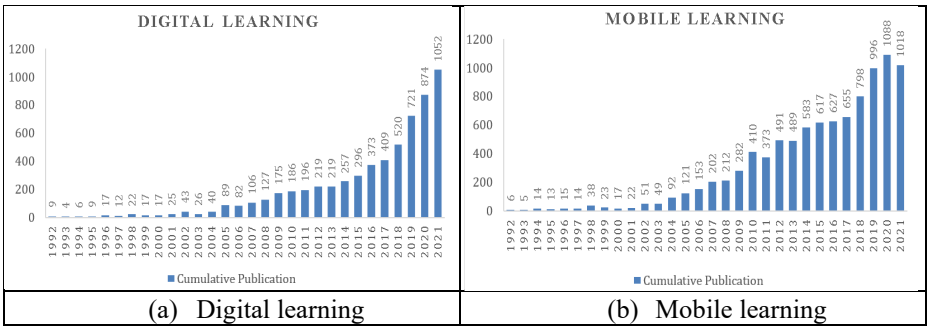


Figure 1. Flowchart research

3 Result and Discussion

3.1 Publication research trend

Figures 1a and 1b show a very significant development in the publication of articles on Scopus over the last thirty years. This shows that the high interest of the academic community towards research and the trends that are developing are very high.



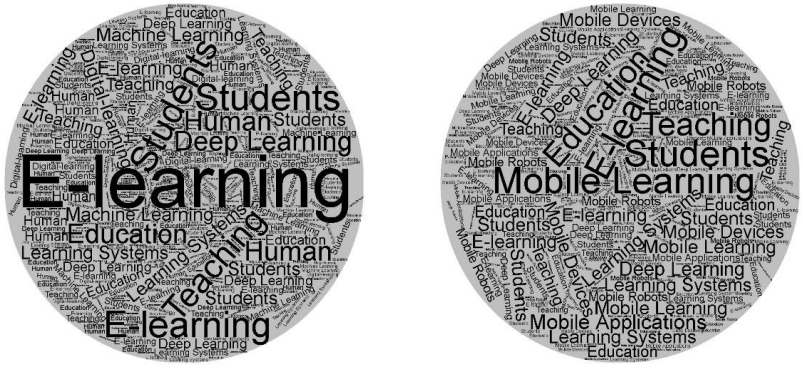
(a) Digital learning (b) Mobile learning

Figure 2. Publication trend digital learning and mobile learning last thirty years

Figure 2 shows the number of articles in the field of digital learning and mobile learning at Scopus. Digital learning in 1992 only amounted to 9 documents. Then the increase occurred continuously which finally in 2021 the published articles had reached thousands, namely 1052 documents. Whereas mobile learning in 1992 only amounted to 6 documents. Then the increase occurred continuously which finally in 2021 the published articles had reached thousands, namely 1018 documents.

3.2 Visualization keyword of papers

The most frequently used keywords are graphically shown in Figure 3. Larger font sizes represent the frequency with which words are used the most. Words that are commonly used in digital learning are E-learning, students, human, teach, deep learning, etc. As for mobile learning, the words that are often used are mobile learning, students, E-learning, teaching, mobile application, education, etc.



(a) Digital Learning (b) Mobile Learning

Figure 3. The most relevant keywords

From 1992 to 2021 there were 6148 Scopus indexed documents with the topic of digital learning. As for the topic of mobile learning from 1992 to 2021, there are 9481 documents. Then the researcher visualized the trend of the topic with the help of VOSViewer which is presented in Figures 3a and 3b. In addition, the brightest color indicates the most updated word related to the BDAG [37].

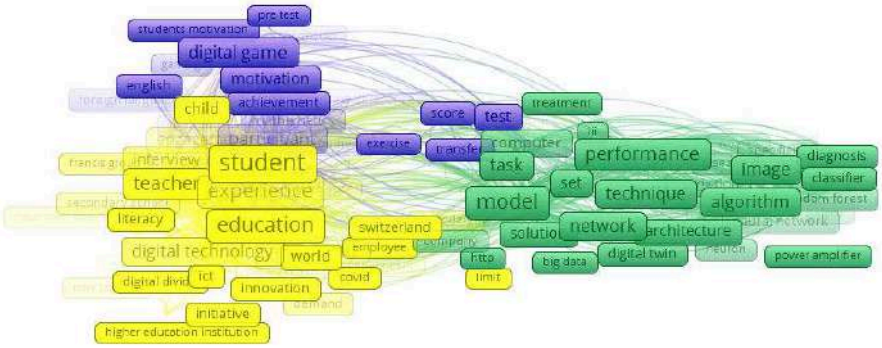


Figure 3a. The network visualization relevance trend in digital learning

Based on Figure 4(a) the relevance trend in digital learning produces three visible color clusters (yellow, green, and purple). In the first cluster (yellow color) are student, education, limit, initiative, higher education institution, innovation, ict, covid, world, digital technology, employee, switzerland, literacy, teacher, experience, interview, and etc. The second cluster (green color) is model, http, big data, solution, task, computer,

treatment, set, performance, technique, network, digital twin, architecture, algorithm, image, power amplifier, classifier, diagnosis, and etc. The third cluster (purple color) is test, transfer, exercise, score, achievement, motivation, digital game, english, pre test, students motivation, and etc. In addition, the lightest color indicates the most updated word related to the topics [37].

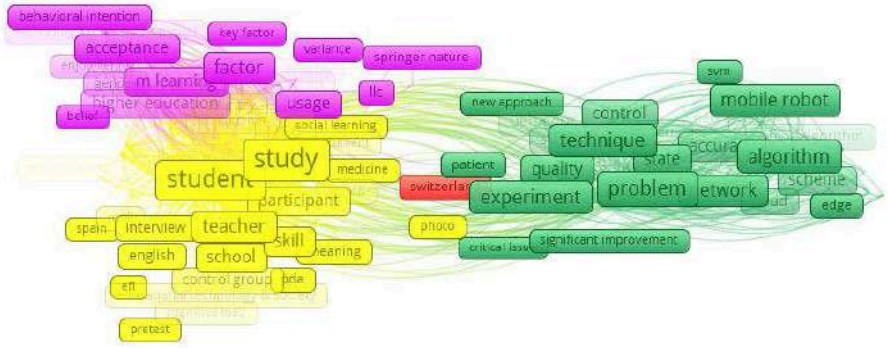


Figure 4b. The network visualization relevance trend in mobile learning

Based on Figure 4(b) the relevance trend in digital learning resulted in four visible color clusters (yellow, green, purple, and red). In the first cluster (yellow color) are study, student, participant, teacher, skill, learning, school, pretest, english, spain, interview, control group, social learning, medicine, photo, and etc. The second cluster (green) is problem, critical issue, significant improvement, experiment, patient, quality, technique, new approach, control, state, network, algorithm, mobile robot, edge, and etc. The third cluster (purple) is usage, ilc, springer nature, variance, factor, key factor, m-learning, belief, higher education, acceptance, behavioral intention, and etc. Cluster four (red) is Switzerland.

3.3 Publication Type

Table 2. Document type of top cited paper

Document Type	Frequency		Total Cited		Mean		Median		SD	
	DL	**ML**	**DL**	**ML**	**DL**	**ML**	**DL**	**ML**	**DL**	**ML**
Article	80	82	13544*	21680*	169.3	264.4	119.0	212.5	158.8	132.8
Conference Paper	8	11	872	2637	109.0	239.7	92.0	229.0	45.9	65.7
Book	6	2	905	666	150.5	333.0	129.0	333.0	61.8	79.2
Review	4	4	758	1363	189.0*	340.8*	204.0*	339.5*	95.7	103.2
Book Chapter	1	1	88	299	88.0	299.0	88.0	299.0		-
Editorial	1	-	363	-	363.0	-	363.0	-	-	-
Total	**100**	**100**	**16530**	**26647**	**1069.6**	**1477.9**	**-**	**-**	**-**	**-**
*=the highest number										

Document types from the top 100 papers published in digital learning and mobile learning from 1992 to 2021 can be seen in Table 2. The 100 papers for digital learning has six document types, namely, articles (80), Conference paper (8), Book (6), Review (4), Book Chapter (1), and Editorial (1). In addition, the highest and lowest average number of review citations are (363.0) and (88.0) respectively, with the highest standard deviation (158.8). Meanwhile, for 100 mobile learning papers, there are five types of documents, namely articles (82), conference papers (11), books (2), reviews (4), and book chapters (1). Furthermore, for the highest and lowest average number of review citations, respectively (340.0) and (239.0) with the highest standard deviation (132.8).

3.4 Distribution of Top Cited 100 Paper

Table 2. Distribution paper

Digital Learning						Mobile Learning					
Year	**Paper**	**Citation**	**ACPP**	**HAPPY**	**City Year**	**Year**	**Paper**	**Citation**	**ACPP**	**HAPPY**	**Citable**
1992	1	95	95.0	3.2	30	1995	1	202	202.0	7.5	27
1995	2	215	107.5	4.0	27	1996	1	222	222.0	8.5	26
2001	2	414	207.0	9.9	21	1998	2	903	451.5	18.8	24
2004	2	450	225.0	12.5	18	2000	1	601	601.0*	27.3	22
2005	4	1219	304.8	17.9	17	2002	4	872	218.0	10.9	20
2006	2	261	130.5	8.2	16	2003	6	1368	228.0	12.0	19
2007	5	878	175.6	11.7	15	2004	2	471	235.5	13.1	18
2008	5	844	168.8	12.1	14	2005	2	614	307.0	18.1	17
2009	7	2253	321.9*	24.8	13	2006	1	160	160.0	10.0	16
2010	3	410	136.7	11.4	12	2007	8	2170	271.3	18.1	15
2011	7	904	129.1	11.7	11	2008	6	2364	394.0	28.1	14
2012	10	1298	129.8	13.0	10	2009	10*	2856*	285.6	22.0	13
2013	7	1159	165.6	18.4	9	2010	8	1923	240.4	20.0	12
2014	8	860	107.5	13.4	8	2011	7	2328	332.6	30.2	11
2015	4	420	105.0	15.0	7	2012	5	1870	374.0	37.4	10
2016	11*	2433*	221.2	36.9	6	2013	5	1445	289.0	32.1	9
2017	4	5 33	133.3	26.7	5	2014	5	986	197.2	24.7	8
2018	6	807	134.5	33.6	4	2015	2	390	195.0	27.9	7
2019	8	711	88.9	29.6	3	2016	8	2211	276.4	46.1	6
2020	2	274	137.0	68.5*	2	2017	7	1510	215.7	43.1	5
-	-	-	-	-	-	2018	4	774	193.5	48.4	4
-	-	-	-	-	-	2019	4	1181	295.3	98.4*	3
-	-	-	-	-	-	2020	1	225	225.0	112.5	2
Total	100	16438	3224.5	382.3		Total	100	27646	6409.8	715.2	
ACPP= Average Citation Per Paper , ACPPY= Average Citation Per Paper Per Year, *= the highest number											

Based on the Table 2 above, for digital learning and mobile learning, publications do not occur every year. This can be seen in the years that have no paper at all. Furthermore, the top 100 articles on digital learning obtained a total of citations (16438) with an average of (3224.5) citations. The highest citation is (2433) in 2016, the highest average citation is (321.9) in 2009, and the highest average citation per paper per year is (68.5) in 2020. As for mobile learning, it gets a total of citations (27646) with an average (6409.8) citations. The highest citation is (2856) in 2009, the highest average citation is (601.0) in 2000, and the highest average citation per paper per year is (98.4) in 2019.

3.5 Top 10 Authors with more articles

Table 3. Top 10 author with more article

Digital Learning			Mobile Learning		
Author	**Document**	**Country**	**Author**	**Document**	**Country**
Ifenthaler, D	15	Curtin University (Australia)	Hwang, GJ	70	National Taiwan University of Science and Technology (Taiwan)
Lam, EY	14	The University of Hong Kong (Hong Kong)	Huang, YM	39	National Cheng Kung University (Taiwan)
Chen, GD	13	National Central University(Taiwan)	Milrad, M	36	Linnaeus University (Sweden)
Barber, W.	12	Ontario Tech University (Canada)	Kukulska-Hulme, A	34	The Open University, Milton Keynes (United Kingdom)
Hwang, GJ	12	National Taiwan University of Science and Technology (Taiwan)	Wong, LH	34	National Institute of Education (Singapore)
Bandung, Y	11	Bandung Institute of Technology (Indonesia)	Traxler, J	30	University of Wolverhampton (United Kingdom)
Lee, JS	11	The Education University of Hong Kong (Hong Kong)	Looi, CK	29	Center for Research and Development in Learning (Singapore)
Erstad, O	9	Universitetet I Oslo (Norway)	Parsons, D	26	The Mind Lab, Auckland (New Zealand)
Huang, YM	9	National Cheng Kung University (Taiwan)	Sharples, M	26	The Open University, Milton Keynes (United Kingdom)
Sampson, DG	9	University of Piraeus (Greece)	Specht, M	24	Delft University of Technology (Netherlands)

Table 3 shows the top 10 authors' articles with the highest number of documents from 1992 to 2021 from different countries. In digital learning, it is dominated by Ifenthaler, D from Curtin University (Australia) with a total of 15 documents, followed by Lam, EY from The University of Hong Kong (Hong Kong) with a total of 14 documents, and followed by Chen, G.D from National Central University(Taiwan) with the number of diemen (13). Meanwhile, for mobile learning, it was dominated by Hwang, GJ from the National Taiwan University of Science and Technology (Taiwan) with a total of (70) documents, followed by Huang, YM from National Cheng Kung University (Taiwan) with 39 documents, and followed by Milrad, M from Linnaeus University (Sweden) with the number of documents (36).

3.6 Top Country of Publication 100 Highest

Table 4. Top countries 100 cited publication (1992-2021)

Digital Learning				Mobile Learning			
Country	**Article**	**Total Citation**	**Average Article Citation**	**Country**	**Article**	**Total Citation**	**Average Article Citation**
United States	33	6452	195.52	Taiwan	26	8308	319.54
United Kingdom	13	2120	163.08	United States	19	5658	297.79
Taiwan	7	584	83.43	United Kingdom	17	3166	186.24
China	5	435	87.00	Singapore	4	879	219.75
Netherlands	5	1532	306.40	South Korea	3	744	248.00
Australia	4	490	122.50	Switzerland	3	831	277.00
Belgium	4	423	105.75	Australia	3	646	215.33
Finland	4	598	149.50	China	3	626	208.67
Hong Kong	4	548	137.00	Japan	3	622	207.33
Canada	3	1187	395.67	Netherlands	2	373	186.50
Germany	3	475	158.33	Germany	2	400	200.00
South Korea	3	510	170.00	Italy	2	382	191.00
France	1	295	295.00	Turkey	2	353	176.50
Greece	1	984	984.00	Canada	2	400	200.00
Italy	1	74	74.00	South Africa	1	303	303.00
New Zealand	1	137	137.00	Nigeria	1	300	300.00
Norway	1	81	81.00	Hong Kong	1	285	285.00
Oman	1	292	292.00	Malaysia	1	213	213.00
Russian	1	77	77.00	Spain	1	196	196.00
Singapore	1	189	189.00	Portugal	1	180	180.00
Spain	1	305	305.00	Chile	1	170	170.00
Switzerland	1	105	105.00	Finland	1	163	163.00
Thailand	1	74	74.00	France	1	162	162.00
Turkey	1	71	71.00	-	-	-	-
Total	100	18038	4758.2	**Total**	**100**	**25277**	**5061.3**

The calculation of the publication of articles from countries is only based on the affiliation that published the articles. Table 4 shows that there are country differences between the top 100 digital learning papers and the top 100 mobile learning papers. For digital learning, it shows that there are 24 different countries that have produced the top 100. The United States dominates the production of papers with (33) articles, followed by the United Kingdom (13), Taiwan (7), China and the Netherlands respectively (5), Australia, Belgium, Finland, and Hong Kong (4), respectively, Canada, Germany, and South Korea (3), and France, Greece, Italy, New Zealand, Norway, Oman, Russia, Singapore, Spain, Switzerland, and Thailand each (1) article for digital learning. As for mobile learning, it shows that there are 23 different countries that have produced the top 100 articles. Article publications are dominated by Taiwan (26), United States (19), United Kingdom (17), Singapore (4), South Korea, Switzerland, Australia, China, and Japan respectively (3), Netherlands, Germany, Italy, Turkey, and Canada (2) each, and

South Africa, Nigeria, Hong Kong, Malaysia, Spain, Portugal, Chile, Finland, and France each (1) article for mobile learning.

3.7 Top 10 Productive Countries

When analyzing we found the leading countries that have the most publications on digital learning and mobile learning. Each of the top three countries that have the most publications during 1991 to 2021 are the United States (1354 doc), United Kingdom (456 doc), and China (407 doc) for digital learning which can be seen in Figure 5a. As for mobile learning, the top three countries that have the most publications during 1991 to 2021 are China (1390 docs), United States (1359 docs), and United Kingdom (659 docs) which can be seen in Figure 5b.

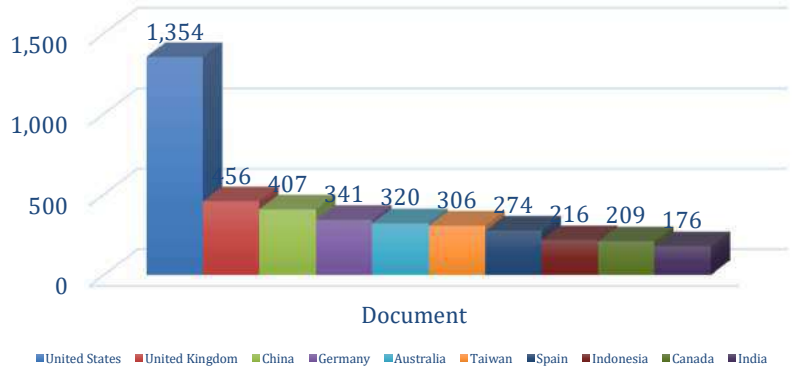


Figure 5a. Top 10 productive countries digital learning

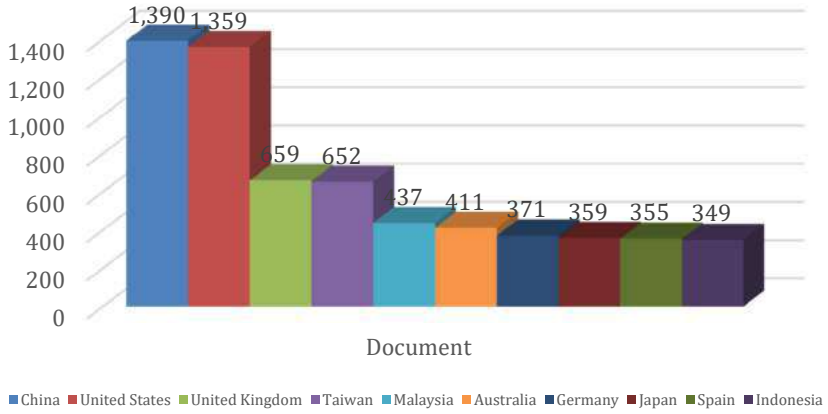


Figure 5b. Top 10 productive countries mobile learning

3.8 The differences and similarities between digital learning and mobile learning

After reviewing literature and other scientific sources, facts are obtained which state that there are so many differences and similarities between digital learning and mobile learning. That way, it is important to discuss this so that it can reduce misconceptions about digital learning and mobile learning. For more details presented in table.5

Table 5. Differences and similarities digital learning and mobile learning

Description	Digital Learning	Mobile Learning
Understanding	Digital learning is a digital learning resource that includes many elements to be used in learning [32]	Mobile learning is a learning model that adopts the development of mobile technology and mobile devices (HP) as a learning medium[33]
Function	Facilitates the learning process and presents more interesting teaching materials [32]	As an alternative to mobile or mobile-based learning services[34]
Forms/types of	● Blended learning ● Online Learning/E-learning ● Use of technology (applications, google, and the like) ● Adaptive learning	● Applications ● Web
Existence	continues to grow	Continuously develops
Devices	HP, notebook, Tablet, PDA, Computer, Web, PC, Tv, CD-ROM, and etc	Mobile, notebook, tablet, smartphone and PDAs.
Features	Video Streaming/live, virtual whiteboards, quizzes/virtual exams, discussion threads, online questionnaires, online TV, and etc [35]	Features that can be used Based on the type of application installed [36]
Scope	Covers all bases digital	According to the specs of the device used
Approach	All media	Certain applications
Size	Flexible	According to device
Application	All applications	Limited applications
Place	Virtual Classroom online, teachers in class, and internet labs	Flexible learning (anywhere and anytime)
Access	Internet	Internet

Based on Table 5 shows the differences and similarities between digital learning and mobile learning. Lots of people say that digital learning and mobile learning are the same thing. Even though there are differences between the two things [38]. In addition,

digital learning includes all what learning is contained in mobile learning. This is because learning that uses mobile learning must be in digital form, whether it be applications, e-books, web, and etc [34, 35, 36, 38]. However, digital learning has so many other devices such as computers, PCs, tablets, and etc [39]. While mobile learning is more dependent on applications, Google, and the web [36]. If illustrated, it will look like figure 6.

Figure 6. relationship illustration digital learning and mobile learning

3.9 The advantages and disadvantages of digital learning and mobile learning

The results of the study of literature and scientific sources related to the topic of digital learning and mobile learning obtained the fact that each of them has advantages and disadvantages in each field. For more details, see Table 6 below.

Table 6. Advantages and disadvantages of digital learning and mobile learning.

Digital Learning	Mobile Learning
Advantages	
● Relatively expensive according to the device used ● Learning depends on the device used (for example, a computer should not be used while traveling while a tablet can be used anywhere) ● Can eliminate some formal learning and make it more interesting ● Types of wireless communication to access all information ● Multiple delivery and content creation options ● Facilitates both individual and collaborative learning experiences ● helps provide and support literacy, numeracy and language learning ● Can increase self-confidence in education ● Increase skills in using technology in learning activities	● Relatively inexpensive because it only uses certain ● cellphones Learning can be done anywhere, anytime, and is personalized ● Can eliminate some formal learning and make it more interesting ● Types of wireless communication to access all information ● Multiple delivery and content creation options ● Facilitate learning experiences both individually and collaboratively ● to help provide and support literacy, numeracy and language learning ● Can increase self-confidence in education ● Increase skills in using technology in learning activities ● Can conduct discussions without having to meet ● Can access teaching materials needed at any time and certainly more attractive

Digital Learning	Mobile Learning
● Can have discussions without having to meet ● Can use teaching materials as needed ● Support distance ● learning that develops in everyday life ● Learning can be followed by more students	● Easier to carry and use ● Supports distance learning Take ● advantage of emerging technologies in everyday life ● Learning can be followed by more students
Disadvantages	
● Can only be used use by people who can afford ● It Always need internet access ● Quickly makes you bored because you don't see each other ● Practical learning can't be done maximally ● Depends on a good network ● Development and learning is more about knowledge ● Can't monitor students individually ● Learning depends on device battery percentage ● Abstract learning is very difficult to understand ● The atmosphere must be conducive ● Requires a lot of help tools such as, Pen Tab, webcam, a good headset.	● Can only be used by people who can afford ● It always requires internet access ● Limited with storage from the device used ● Large practicum applications cannot be installed ● Depends on a good network ● Development and learning is more about knowledge ● Cannot monitor students individually ● Learning depends on HP battery percentage ● Many mobile differences such as iOS, Android, and Apple that can only be used on certain cell phones ● Atmosphere must be conducive ● Small memory capacity ● Small screen view

Based on Table 6 shows the advantages and disadvantages of digital learning and mobile learning. Digital learning and mobile learning are learning alternatives that are growing rapidly in line with technological developments. In addition, the COVID-19 pandemic is still ongoing so that learning is shifted to online. There are advantages and disadvantages to each of the learning carried out as written in table 4. Actually digital learning has been popularized since 1960 by the University of Illinois with the aim only to convey information to students. However, along with the development of technology, digital learning continues to grow rapidly so that it is often used in learning including e-books, e-modul, PPT,and etc [32][43]. In this way, new innovations such as e-learning, blended learning, and mobile learning emerge.

3.10 Research Implication:

- To Researcher, can be the basis for further research in the field of digital-based implementation which has similarities but is in fact different. In addition, you can find out trends in digital-based learning that are in accordance with certain conditions, both nationally and internationally.

- To Librarian, can be a source of new research and knowledge related to the development of digital-based learning in an increasingly advanced era with technology
- To Policymakers, can provide sources of information on digital research topics that are growing rapidly so that they can make decisions with certain considerations based on valid information obtained.

4 Conclusion

Digital learning and mobile learning are two different things but still have something in common. Learning with mobile learning is an innovation from digital learning. Based on Scopus data from 1992 to 2021, digital learning and mobile learning publications have on average experienced a significant increase. This is due to following technological developments and due to the ongoing COVID-19 pandemic. Based on the results that have been presented, it can be seen the trends, differences, similarities, advantages, and disadvantages of digital learning and mobile learning. Thus, it is hoped that this discovery can be a reference for future discoveries in aspects of digital-based learning.

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Top 100 Cited Publications for The Last Thirty Years in Digital Learning and Mobile Learning

https://doi.org/10.3991/ijim.v16i08.29803

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Abstract—Digital learning and mobile learning are two different things but have something in common. This research aims to find trends, topics, similarities, differences, advantages, and disadvantages of digital learning and mobile learning over the last thirty years (1992–2021). The method used in this research is bibliometric analysis with the help of Ms-excel, VOSViewer, and Wordcloud to visualize the metadata obtained from Scopus. The findings show that the trend of digital learning continues to increase from year to year. In addition, it can explain that mobile learning is an innovative part of digital learning with almost the same differences, similarities, advantages, and disadvantages. In the future, it is hoped that further research related to digital learning will continue to develop along with technological developments.

Keywords—bibliometric, digital learning, mobile learning, VOSViewer

1 Introduction

Education is so important for humans because it is one of the paths to success regardless of origin. This is evidenced by learning and development of knowledge from time to time continues to grow [1][2]. This is compounded by the existence of new policies that continue to change from year to year. There are so many changes that occur in the world of education [3][4]. According to [5][6], education is very important to continue to be developed in order to provide learning opportunities for all groups. In addition, education is included in the world leader's action plan known as the SDGs (Sustainable Development Goals) [7][8]. Major changes occurred during the Covid-19 pandemic. This causes learning to switch from offline (direct) to online (virtual) [9][10]. That way, new innovations and terms have emerged, such as learning platforms, learning applications, digital learning, online learning, web learning, e-modules, e-books, and many more. Several studies have been conducted regarding online learning models including mobile learning, the effectiveness of digital technology, digital readiness, digital comics, and usability of mobile learning apps [11][12][13][14][15].

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Digital learning and mobile learning are the main topics of discussion in the world of education today [16][17]. This will certainly continue to grow along with technological developments. However, it is necessary to know about these developments through research that has been carried out by various authors and institutions by looking at the publications of previous studies to date in the form of conference proceedings, journal articles and other scientific media [18][19]. According to Yeaung et al. [20], to see the most impactful topics is not easy to access. Therefore, there is a need for bibliometric analysis to identify and explore impactful topics [14][21]. Using bibliometric analysis can provide a valid review quality, visualize salient areas, improve understanding of the distribution of a research topic, and provide clues for future research [22][23][24]. In addition, bibliometric analysis is assisted by using the VOSViewer, MS-Excel, and Word cloud software in visualizing the research results to make it more interesting.

The purpose of this study is to conduct a literature review related to digital learning and mobile learning topics for one hundred cited in the last thirty years from 1992 to 2021 using bibliometric analysis. There are several research questions were asked to help achieve the specific research problem:

1. What are the trends of publication from 1992 to 2021 in digital learning and mobile learning?
2. What are the types of publication of the top one hundred cited papers in digital learning and mobile learning?
3. How is the distribution of the top 100 papers quoted from digital learning and mobile learning?
4. Who are the prolific authors of the top one hundred cited papers in digital learning and mobile learning?
5. Which countries are most interested in digital learning research and mobile learning?
6. What are the differences and similarities between digital learning and mobile learning?
7. What are the advantages and disadvantages of digital learning and mobile learning?

2 Methodology

This research is a type of quantitative research based on the Scopus database. Then, using bibliometric analysis that can prove and find novelty and trends in research [25][26][27][28]. Data collection was obtained through a Scopus search as of 23 January 2022 with the following criteria;

Table 1. Screening data

Description	Digital Learning	Mobile Learning
Keywords	Title (digital AND earning)	Title (mobile AND learning)
Document All Year	6255 Document	9542 document
Document year (1992–2021)	6148 Document	9481 document

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Then the metadata is saved in csv format. and risk. After that, further analysis was carried out using software such as MS-Excel, VOSViewer, and WordCloud to make the data display more attractive [25][29][30]. According to Putri et al. [31] the effectiveness of VOSViewer has been proven in a recent study that has been carried out with the Scopus index.

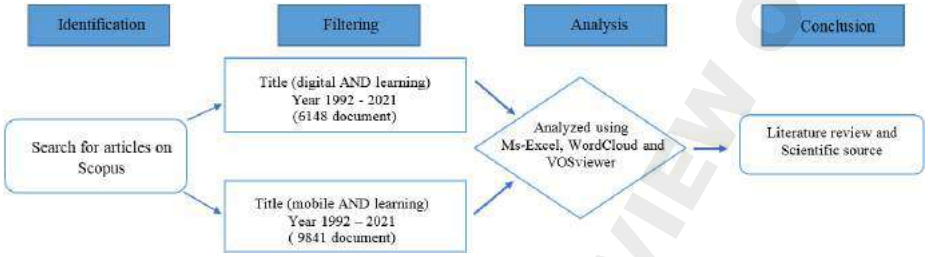
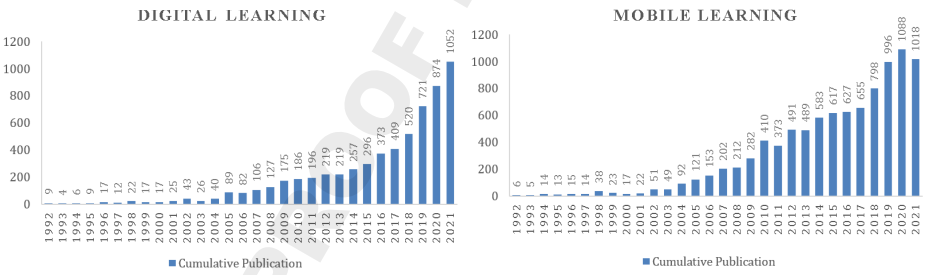


Fig. 1. Flowchart research

3 Result and discussion

3.1 Publication research trend

Figures 1a and 1b show a very significant development in the publication of articles on Scopus over the last thirty years. This shows that the high interest of the academic community towards research and the trends that are developing are very high.



a) Digital Learning **b) Mobile Learning**

Fig. 2. Publication trend digital learning and mobile learning last thirty years

Figure 2 shows the number of articles in the field of digital learning and mobile learning at Scopus. Digital learning in 1992 only amounted to 9 documents. Then the increase occurred continuously which finally in 2021 the published articles had reached thousands, namely 1052 documents. Whereas mobile learning in 1992 only amounted to 6 documents. Then the increase occurred continuously which finally in 2021 the published articles had reached thousands, namely 1018 documents.

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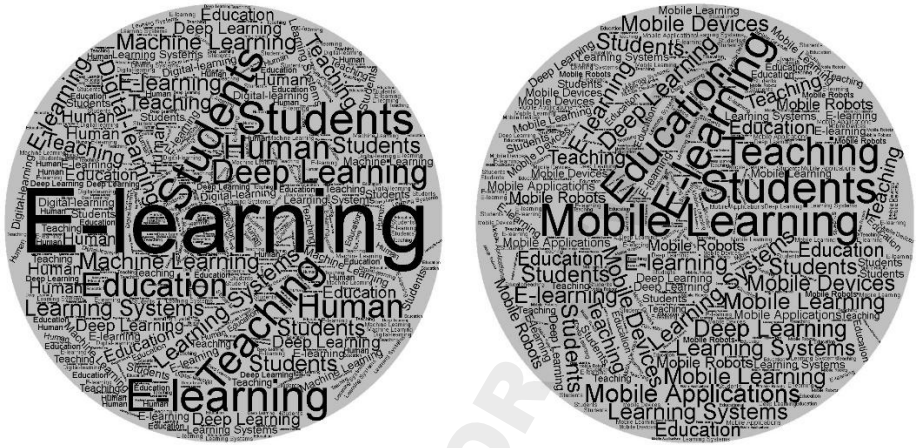
3.2 Visualization keyword of papers

The most frequently used keywords are graphically shown in Figure 3. Larger font sizes represent the frequency with which words are used the most. Words that are commonly used in digital learning are E-learning, students, human, teach, deep learning, etc. As for mobile learning, the words that are often used are mobile learning, students, E-learning, teaching, mobile application, education, etc.



a) Digital Learning **b) Mobile Learning**

Fig. 3. The most relevant keywords

From 1992 to 2021 there were 6148 Scopus indexed documents with the topic of digital learning. As for the topic of mobile learning from 1992 to 2021, there are 9481 documents. Then the researcher visualized the trend of the topic with the help of VOSViewer which is presented in Figures 3a and 3b. In addition, the brightest color indicates the most updated word related to the BDAG [37].

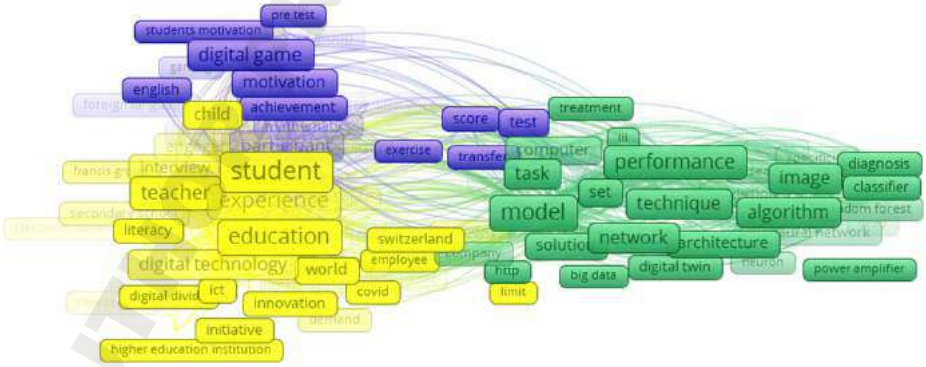


Fig. 4a. The network visualization relevance trend in digital learning

Based on Figure 4(a) the relevance trend in digital learning produces three visible color clusters (yellow, green, and purple). In the first cluster (yellow color) are student,

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education, limit, initiative, higher education institution, innovation, ict, covid, world, digital technology, employee, switzerland, literacy, teacher, experience, interview, and etc. The second cluster (green color) is model, http, big data, solution, task, computer, treatment, set, performance, technique, network, digital twin, architecture, algorithm, image, power amplifier, classifier, diagnosis, and etc. The third cluster (purple color) is test, transfer, exercise, score, achievement, motivation, digital game, english, pre test, students motivation, and etc. In addition, the lightest color indicates the most updated word related to the topics [37].

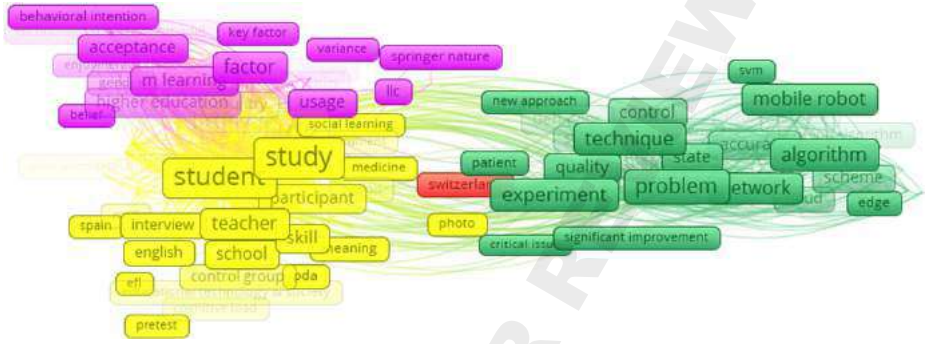

Fig. 4b. The network visualization relevance trend in mobile learning

Based on Figure 4(b) the relevance trend in digital learning resulted in four visible color clusters (yellow, green, purple, and red). In the first cluster (yellow color) are study, student, participant, teacher, skill, learning, school, pretest, english, spain, interview, control group, social learning, medicine, photo, and etc. The second cluster (green) is problem, critical issue, significant improvement, experiment, patient, quality, technique, new approach, control, state, network, algorithm, mobile robot, edge, and etc. The third cluster (purple) is usage, ilc, springer nature, variance, factor, key factor, m-learning, belief, higher education, acceptance, behavioral intention, and etc. Cluster four (red) is Switzerland.

3.3 Publication type

Table 2. Document type of top cited paper

Document Type	Frequency		Total Cited		Mean		Median		SD	
	DL	ML	DL	ML	DL	ML	DL	ML	DL	ML
Article	80	82	13544*	21680*	169.3	264.4	119.0	212.5	158.8	132.8
Conference Paper	8	11	872	2637	109.0	239.7	92.0	229.0	45.9	65.7
Book	6	2	905	666	150.5	333.0	129.0	333.0	61.8	79.2
Review	4	4	758	1363	189.0*	340.8*	204.0*	339.5*	95.7	103.2
Book Chapter	1	1	88	299	88.0	299.0	88.0	299.0		–
Editorial	1	–	363	–	363.0	–	363.0	–	–	–
Total	**100**	**100**	**16530**	**26647**	**1069.6**	**1477.9**	–	–	–	–

Note: *=the highest number.

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Document types from the top 100 papers published in digital learning and mobile learning from 1992 to 2021 can be seen in Table 2. The 100 papers for digital learning has six document types, namely, articles (80), Conference paper (8), Book (6), Review (4), Book Chapter (1), and Editorial (1). In addition, the highest and lowest average number of review citations are (363.0) and (88.0) respectively, with the highest standard deviation (158.8). Meanwhile, for 100 mobile learning papers, there are five types of documents, namely articles (82), conference papers (11), books (2), reviews (4), and book chapters (1). Furthermore, for the highest and lowest average number of review citations, respectively (340.0) and (239.0) with the highest standard deviation (132.8).

3.4 Distribution of top cited 100 paper

Table 3. Distribution paper

Digital Learning						Mobile Learning					
Year	**Paper**	**Citation**	**ACPP**	**HAPPY**	**City Year**	**Year**	**Paper**	**Citation**	**ACPP**	**HAPPY**	**Citable**
1992	1	95	95.0	3.2	30	1995	1	202	202.0	7.5	27
1995	2	215	107.5	4.0	27	1996	1	222	222.0	8.5	26
2001	2	414	207.0	9.9	21	1998	2	903	451.5	18.8	24
2004	2	450	225.0	12.5	18	2000	1	601	601.0*	27.3	22
2005	4	1219	304.8	17.9	17	2002	4	872	218.0	10.9	20
2006	2	261	130.5	8.2	16	2003	6	1368	228.0	12.0	19
2007	5	878	175.6	11.7	15	2004	2	471	235.5	13.1	18
2008	5	844	168.8	12.1	14	2005	2	614	307.0	18.1	17
2009	7	2253	321.9*	24.8	13	2006	1	160	160.0	10.0	16
2010	3	410	136.7	11.4	12	2007	8	2170	271.3	18.1	15
2011	7	904	129.1	11.7	11	2008	6	2364	394.0	28.1	14
2012	10	1298	129.8	13.0	10	2009	10*	2856*	285.6	22.0	13
2013	7	1159	165.6	18.4	9	2010	8	1923	240.4	20.0	12
2014	8	860	107.5	13.4	8	2011	7	2328	332.6	30.2	11
2015	4	420	105.0	15.0	7	2012	5	1870	374.0	37.4	10
2016	11*	2433*	221.2	36.9	6	2013	5	1445	289.0	32.1	9
2017	4	533	133.3	26.7	5	2014	5	986	197.2	24.7	8
2018	6	807	134.5	33.6	4	2015	2	390	195.0	27.9	7
2019	8	711	88.9	29.6	3	2016	8	2211	276.4	46.1	6
2020	2	274	137.0	68.5*	2	2017	7	1510	215.7	43.1	5
–	–	–	–	–	–	2018	4	774	193.5	48.4	4
–	–	–	–	–	–	2019	4	1181	295.3	98.4*	3
–	–	–	–	–	–	2020	1	225	225.0	112.5	2
Total	100	16438	3224.5	382.3		Total	100	27646	6409.8	715.2	

Notes: ACPP= Average Citation Per Paper , ACPPY= Average Citation Per Paper Per Year, *= the highest number.

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Based on the Table 3 above, for digital learning and mobile learning, publications do not occur every year. This can be seen in the years that have no paper at all. Furthermore, the top 100 articles on digital learning obtained a total of citations (16438) with an average of (3224.5) citations. The highest citation is (2433) in 2016, the highest average citation is (321.9) in 2009, and the highest average citation per paper per year is (68.5) in 2020. As for mobile learning, it gets a total of citations (27646) with an average (6409.8) citations. The highest citation is (2856) in 2009, the highest average citation is (601.0) in 2000, and the highest average citation per paper per year is (98.4) in 2019.

3.5 Top 10 authors with more articles

Table 4. Top 10 author with more article

Digital Learning			Mobile Learning		
Author	**Document**	**Country**	**Author**	**Document**	**Country**
Ifenthaler, D	15	Curtin University (Australia)	Hwang, GJ	70	National Taiwan University of Science and Technology (Taiwan)
Lam, EY	14	The University of Hong Kong (Hong Kong)	Huang, YM	39	National Cheng Kung University (Taiwan)
Chen, GD	13	National Central University(Taiwan)	Milrad, M	36	Linnaeus University (Sweden)
Barber, W.	12	Ontario Tech University (Canada)	Kukulska-Hulme, A	34	The Open University, Milton Keynes (United Kingdom)
Hwang, GJ	12	National Taiwan University of Science and Technology (Taiwan)	Wong, LH	34	National Institute of Education (Singapore)
Bandung, Y	11	Bandung Institute of Technology (Indonesia)	Traxler, J	30	University of Wolverhampton (United Kingdom)
Lee, JS	11	The Education University of Hong Kong (Hong Kong)	Looi, CK	29	Center for Research and Development in Learning (Singapore)
Erstad, O	9	Universitetet I Oslo (Norway)	Parsons, D	26	The Mind Lab, Auckland (New Zealand)
Huang, YM	9	National Cheng Kung University (Taiwan)	Sharples, M	26	The Open University, Milton Keynes (United Kingdom)
Sampson, DG	9	University of Piraeus (Greece)	Specht, M	24	Delft University of Technology (Netherlands)

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Table 4 shows the top 10 authors' articles with the highest number of documents from 1992 to 2021 from different countries. In digital learning, it is dominated by Ifenthaler, D from Curtin University (Australia) with a total of 15 documents, followed by Lam, EY from The University of Hong Kong (Hong Kong) with a total of 14 documents, and followed by Chen, G.D from National Central University(Taiwan) with the number of diemen (13). Meanwhile, for mobile learning, it was dominated by Hwang, GJ from the National Taiwan University of Science and Technology (Taiwan) with a total of (70) documents, followed by Huang, YM from National Cheng Kung University (Taiwan) with 39 documents, and followed by Milrad, M from Linnaeus University (Sweden) with the number of documents (36).

3.6 Top country of publication 100 highest

Table 5. Top countries 100 cited publication (1992–2021)

Digital Learning				Mobile Learning			
Country	**Article**	**Total Citation**	**Average Article Citation**	**Country**	**Article**	**Total Citation**	**Average Article Citation**
United States	33	6452	195.52	Taiwan	26	8308	319.54
United Kingdom	13	2120	163.08	United States	19	5658	297.79
Taiwan	7	584	83.43	United Kingdom	17	3166	186.24
China	5	435	87.00	Singapore	4	879	219.75
Netherlands	5	1532	306.40	South Korea	3	744	248.00
Australia	4	490	122.50	Switzerland	3	831	277.00
Belgium	4	423	105.75	Australia	3	646	215.33
Finland	4	598	149.50	China	3	626	208.67
Hong Kong	4	548	137.00	Japan	3	622	207.33
Canada	3	1187	395.67	Netherlands	2	373	186.50
Germany	3	475	158.33	Germany	2	400	200.00
South Korea	3	510	170.00	Italy	2	382	191.00
France	1	295	295.00	Turkey	2	353	176.50
Greece	1	984	984.00	Canada	2	400	200.00
Italy	1	74	74.00	South Africa	1	303	303.00
New Zealand	1	137	137.00	Nigeria	1	300	300.00
Norway	1	81	81.00	Hong Kong	1	285	285.00
Oman	1	292	292.00	Malaysia	1	213	213.00
Russian	1	77	77.00	Spain	1	196	196.00
Singapore	1	189	189.00	Portugal	1	180	180.00
Spain	1	305	305.00	Chile	1	170	170.00
Switzerland	1	105	105.00	Finland	1	163	163.00
Thailand	1	74	74.00	France	1	162	162.00
Turkey	1	71	71.00	–	–	–	–
Total	100	18038	4758.2	**Total**	**100**	**25277**	**5061.3**

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The calculation of the publication of articles from countries is only based on the affiliation that published the articles. Table 5 shows that there are country differences between the top 100 digital learning papers and the top 100 mobile learning papers. For digital learning, it shows that there are 24 different countries that have produced the top 100. The United States dominates the production of papers with (33) articles, followed by the United Kingdom (13), Taiwan (7), China and the Netherlands respectively (5), Australia, Belgium, Finland, and Hong Kong (4), respectively, Canada, Germany, and South Korea (3), and France, Greece, Italy, New Zealand, Norway, Oman, Russia, Singapore, Spain, Switzerland, and Thailand each (1) article for digital learning. As for mobile learning, it shows that there are 23 different countries that have produced the top 100 articles. Article publications are dominated by Taiwan (26), United States (19), United Kingdom (17), Singapore (4), South Korea, Switzerland, Australia, China, and Japan respectively (3), Netherlands, Germany, Italy, Turkey, and Canada (2) each, and South Africa, Nigeria, Hong Kong, Malaysia, Spain, Portugal, Chile, Finland, and France each (1) article for mobile learning.

3.7 Top 10 productive countries

When analyzing we found the leading countries that have the most publications on digital learning and mobile learning. Each of the top three countries that have the most publications during 1991 to 2021 are the United States (1354 doc), United Kingdom (456 doc), and China (407 doc) for digital learning which can be seen in Figure 5a. As for mobile learning, the top three countries that have the most publications during 1991 to 2021 are China (1390 docs), United States (1359 docs), and United Kingdom (659 docs) which can be seen in Figure 5b.

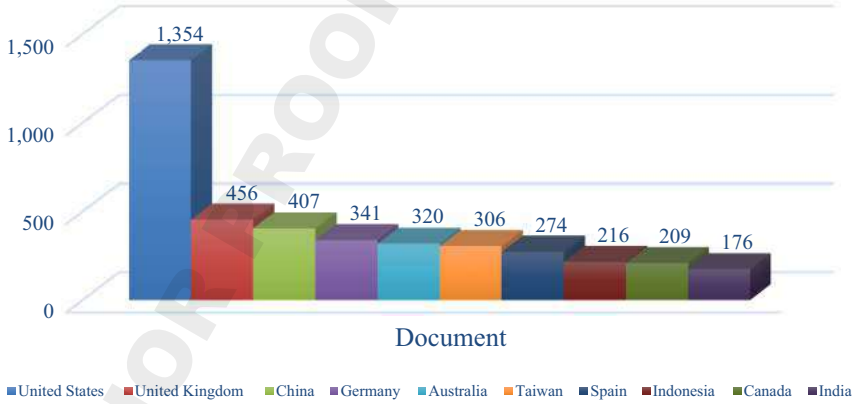

Fig. 5a. Top 10 productive countries digital learning

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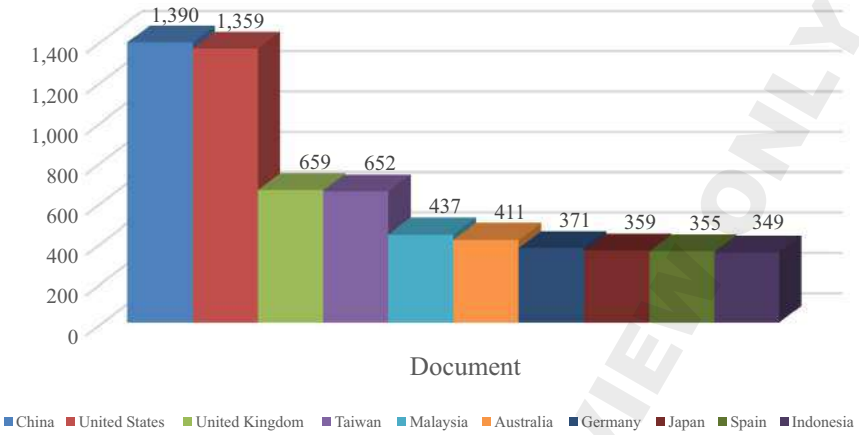

Fig. 5b. Top 10 productive countries mobile learning

3.8 The differences and similarities between digital learning and mobile learning

After reviewing literature and other scientific sources, facts are obtained which state that there are so many differences and similarities between digital learning and mobile learning. That way, it is important to discuss this so that it can reduce misconceptions about digital learning and mobile learning. For more details presented in Table 6.

Table 6. Differences and similarities digital learning and mobile learning

Description	Digital Learning	Mobile Learning
Understanding	Digital learning is a digital learning resource that includes many elements to be used in learning [32]	Mobile learning is a learning model that adopts the development of mobile technology and mobile devices (HP) as a learning medium [33]
Function	Facilitates the learning process and presents more interesting teaching materials [32]	As an alternative to mobile or mobile-based learning services [34]
Forms/types of	• Blended learning • Online Learning/E-learning • Use of technology (applications, google, and the like) • Adaptive learning	• Applications • Web
Existence	continues to grow	Continuously develops
Devices	HP, notebook, Tablet, PDA, Computer, Web, PC, TV, CD-ROM, and etc	Mobile, notebook, tablet, smartphone and PDAs.
Features	Video Streaming/live, virtual whiteboards, quizzes/virtual exams, discussion threads, online questionnaires, online TV, and etc [35]	Features that can be used Based on the type of application installed [36]

(*Continued*)

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Table 6. Differences and similarities digital learning and mobile learning (*Continued*)

Description	Digital Learning	Mobile Learning
Scope	Covers all bases digital	According to the specs of the device used
Approach	All media	Certain applications
Size	Flexible	According to device
Application	All applications	Limited applications
Place	Virtual Classroom online, teachers in class, and internet labs	Flexible learning (anywhere and anytime)
Access	Internet	Internet

Based on Table 6 shows the differences and similarities between digital learning and mobile learning. Lots of people say that digital learning and mobile learning are the same thing. Even though there are differences between the two things [38]. In addition, digital learning includes all what learning is contained in mobile learning. This is because learning that uses mobile learning must be in digital form, whether it be applications, e-books, web, and etc [34, 35, 36, 38]. However, digital learning has so many other devices such as computers, PCs, tablets, and etc [39]. While mobile learning is more dependent on applications, Google, and the web [36]. If illustrated, it will look like Figure 6.

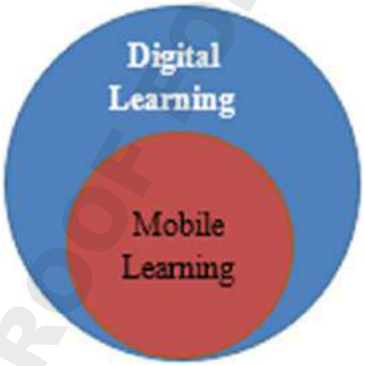

Fig. 6. Relationship illustration digital learning and mobile learning

3.9 The advantages and disadvantages of digital learning and mobile learning

The results of the study of literature and scientific sources related to the topic of digital learning and mobile learning obtained the fact that each of them has advantages and disadvantages in each field. For more details, see Table 7 below.

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Table 7. Advantages and disadvantages of digital learning and mobile learning

Digital Learning	Mobile Learning
Advantages	
• Relatively expensive according to the device used • Learning depends on the device used (for example, a computer should not be used while traveling while a tablet can be used anywhere) • Can eliminate some formal learning and make it more interesting • Types of wireless communication to access all information • Multiple delivery and content creation options • Facilitates both individual and collaborative learning experiences • helps provide and support literacy, numeracy and language learning • Can increase self-confidence in education • Increase skills in using technology in learning activities • Can have discussions without having to meet • Can use teaching materials as needed • Support distance • learning that develops in everyday life • Learning can be followed by more students	• Relatively inexpensive because it only uses certain • cellphones Learning can be done anywhere, anytime, and is personalized • Can eliminate some formal learning and make it more interesting • Types of wireless communication to access all information • Multiple delivery and content creation options • Facilitate learning experiences both individually and collaboratively • to help provide and support literacy, numeracy and language learning • Can increase self-confidence in education • Increase skills in using technology in learning activities • Can conduct discussions without having to meet • Can access teaching materials needed at any time and certainly more attractive • Easier to carry and use • Supports distance learning Take • advantage of emerging technologies in everyday life • Learning can be followed by more students
Disadvantages	
• Can only be used use by people who can afford • It Always need internet access • Quickly makes you bored because you don't see each other • Practical learning can't be done maximally • Depends on a good network • Development and learning is more about knowledge • Can't monitor students individually • Learning depends on device battery percentage • Abstract learning is very difficult to understand • The atmosphere must be conducive • Requires a lot of help tools such as, Pen Tab, webcam, a good headset.	• Can only be used by people who can afford • It always requires internet access • Limited with storage from the device used • Large practicum applications cannot be installed • Depends on a good network • Development and learning is more about knowledge • Cannot monitor students individually • Learning depends on HP battery percentage • Many mobile differences such as iOS, Android, and Apple that can only be used on certain cell phones • Atmosphere must be conducive • Small memory capacity • Small screen view

Based on Table 7 shows the advantages and disadvantages of digital learning and mobile learning. Digital learning and mobile learning are learning alternatives that are growing rapidly in line with technological developments. In addition, the COVID-19 pandemic is still ongoing so that learning is shifted to online. There are advantages and disadvantages to each of the learning carried out as written in Table 5. Actually digital learning has been popularized since 1960 by the University of Illinois with the aim only to convey information to students. However, along with the development of technology, digital learning continues to grow rapidly so that it is often used in learning

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including e-books, e-modul, PPT, and etc [32][43]. In this way, new innovations such as e-learning, blended learning, and mobile learning emerge.

3.10 Research implication

- To Researcher, can be the basis for further research in the field of digital-based implementation which has similarities but is in fact different. In addition, you can find out trends in digital-based learning that are in accordance with certain conditions, both nationally and internationally.
- To Librarian, can be a source of new research and knowledge related to the development of digital-based learning in an increasingly advanced era with technology
- To Policymakers, can provide sources of information on digital research topics that are growing rapidly so that they can make decisions with certain considerations based on valid information obtained.

4 Conclusion

Digital learning and mobile learning are two different things but still have something in common. Learning with mobile learning is an innovation from digital learning. Based on Scopus data from 1992 to 2021, digital learning and mobile learning publications have on average experienced a significant increase. This is due to following technological developments and due to the ongoing COVID-19 pandemic. Based on the results that have been presented, it can be seen the trends, differences, similarities, advantages, and disadvantages of digital learning and mobile learning. Thus, it is hoped that this discovery can be a reference for future discoveries in aspects of digital-based learning.

5 Acknowledgment

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All author are members from grant research and take part in the jobs.

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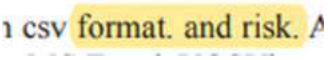
Statement:

Data collection was obtained through a Scopus search as of 23 January 2022 with the following criteria;

Correction:

Data collection was obtained through a Scopus search as of 23 January 2022 with the following criteria in Table 1.

Statement:



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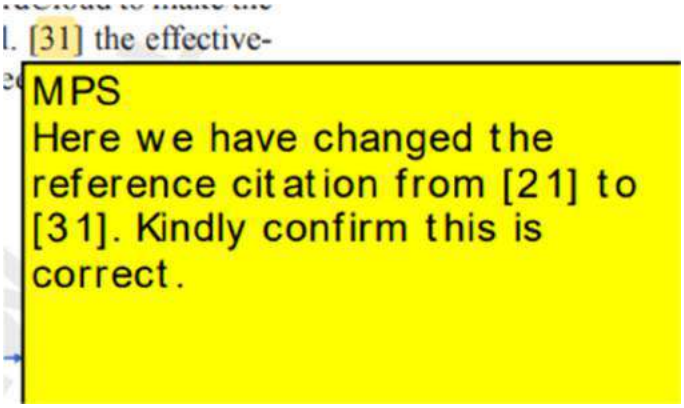

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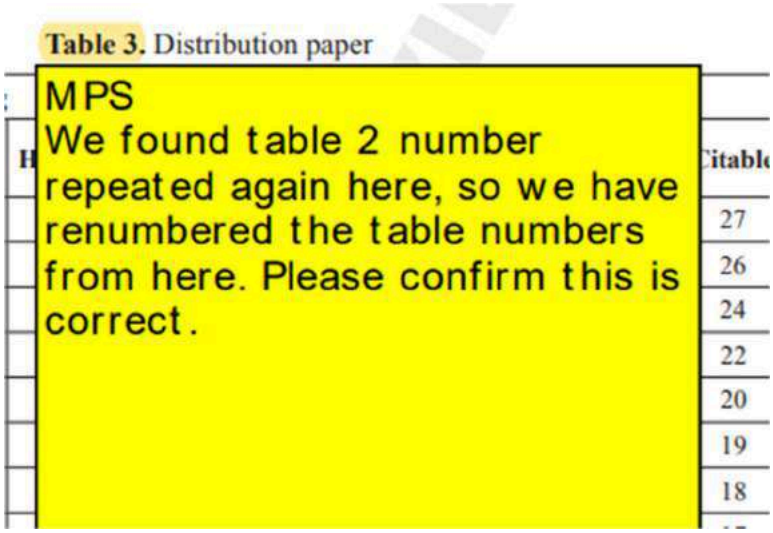

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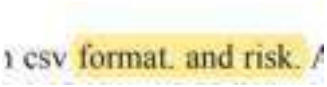

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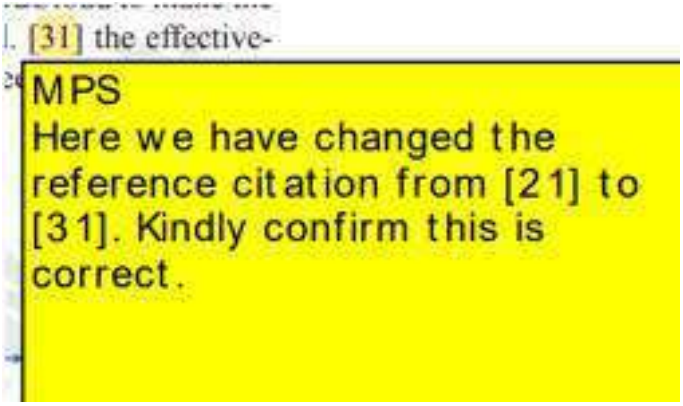

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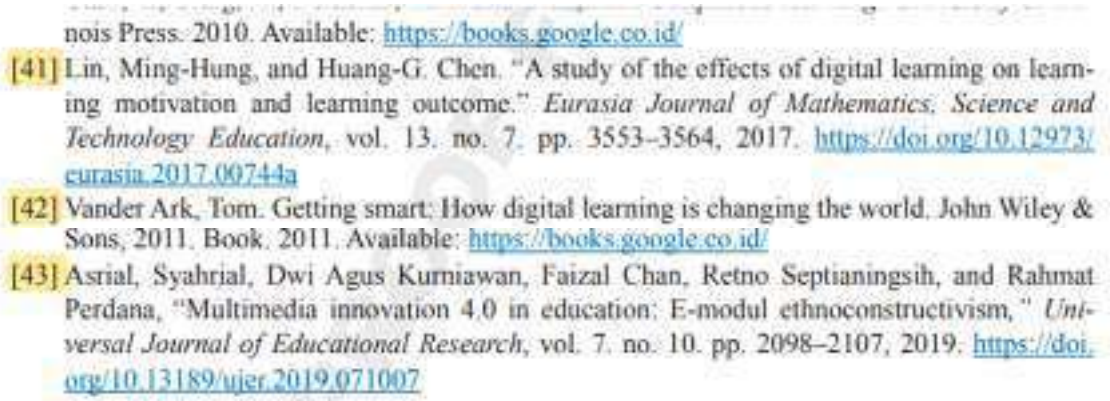

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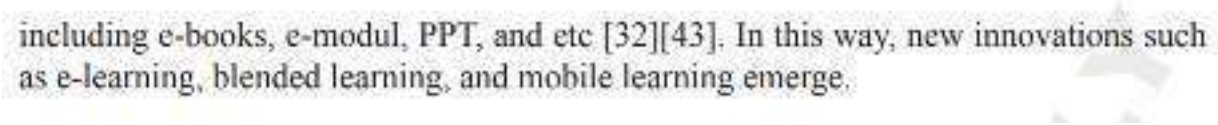

including e-books, e-modul, PPT, and etc [32][41-43]. In this way, new innovations such as e-learning, blended learning, and mobile learning emerge.

Top 100 Cited Publications for The Last Thirty Years in Digital Learning and Mobile Learning

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Abstract—Digital learning and mobile learning are two different things but have something in common. This research aims to find trends, topics, similarities, differences, advantages, and disadvantages of digital learning and mobile learning over the last thirty years (1992–2021). The method used in this research is bibliometric analysis with the help of Ms-excel, VOSViewer, and Wordcloud to visualize the metadata obtained from Scopus. The findings show that the trend of digital learning continues to increase from year to year. In addition, it can explain that mobile learning is an innovative part of digital learning with almost the same differences, similarities, advantages, and disadvantages. In the future, it is hoped that further research related to digital learning will continue to develop along with technological developments.

Keywords—bibliometric, digital learning, mobile learning, VOSViewer

1 Introduction

Education is so important for humans because it is one of the paths to success regardless of origin. This is evidenced by learning and development of knowledge from time to time continues to grow [1][2]. This is compounded by the existence of new policies that continue to change from year to year. There are so many changes that occur in the world of education [3][4]. According to [5][6], education is very important to continue to be developed in order to provide learning opportunities for all groups. In addition, education is included in the world leader's action plan known as the SDGs (Sustainable Development Goals) [7][8]. Major changes occurred during the Covid-19 pandemic. This causes learning to switch from offline (direct) to online (virtual) [9][10]. That way, new innovations and terms have emerged, such as learning platforms, learning applications, digital learning, online learning, web learning, e-modules, e-books, and many more. Several studies have been conducted regarding online learning models including mobile learning, the effectiveness of digital technology, digital readiness, digital comics, and usability of mobile learning apps [11][12][13][14][15].

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Digital learning and mobile learning are the main topics of discussion in the world of education today [16][17]. This will certainly continue to grow along with technological developments. However, it is necessary to know about these developments through research that has been carried out by various authors and institutions by looking at the publications of previous studies to date in the form of conference proceedings, journal articles and other scientific media [18][19]. According to Yeaung et al. [20], to see the most impactful topics is not easy to access. Therefore, there is a need for bibliometric analysis to identify and explore impactful topics [14][21]. Using bibliometric analysis can provide a valid review quality, visualize salient areas, improve understanding of the distribution of a research topic, and provide clues for future research [22][23][24]. In addition, bibliometric analysis is assisted by using the VOSViewer, MS-Excel, and Word cloud software in visualizing the research results to make it more interesting.

The purpose of this study is to conduct a literature review related to digital learning and mobile learning topics for one hundred cited in the last thirty years from 1992 to 2021 using bibliometric analysis. There are several research questions were asked to help achieve the specific research problem:

1. What are the trends of publication from 1992 to 2021 in digital learning and mobile learning?
2. What are the types of publication of the top one hundred cited papers in digital learning and mobile learning?
3. How is the distribution of the top 100 papers quoted from digital learning and mobile learning?
4. Who are the prolific authors of the top one hundred cited papers in digital learning and mobile learning?
5. Which countries are most interested in digital learning research and mobile learning?
6. What are the differences and similarities between digital learning and mobile learning?
7. What are the advantages and disadvantages of digital learning and mobile learning?

2 Methodology

This research is a type of quantitative research based on the Scopus database. Then, using bibliometric analysis that can prove and find novelty and trends in research [25][26][27][28]. Data collection was obtained through a Scopus search as of 23 January 2022 with the following criteria in Table 1.

Table 1. Screening data

Description	Digital Learning	Mobile Learning
Keywords	Title (digital AND earning)	Title (mobile AND learning)
Document All Year	6255 Document	9542 document
Document year (1992–2021)	6148 Document	9481 document

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Then the metadata is saved in *csv* and *ris*. format. After that, further analysis was carried out using software such as MS-Excel, VOSViewer, and WordCloud to make the data display more attractive [25][29][30]. According to Putri et al. [31] the effectiveness of VOSViewer has been proven in a recent study that has been carried out with the Scopus index.

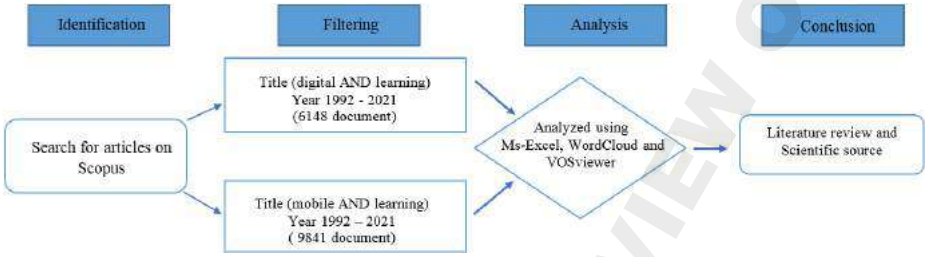
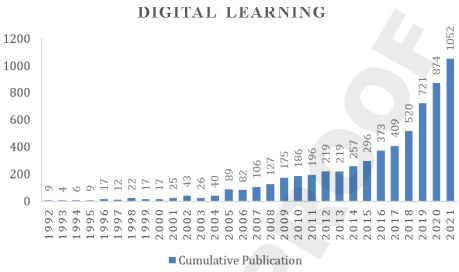


Fig. 1. Flowchart research

3 Result and discussion

3.1 Publication research trend

Figures 1a and 1b show a very significant development in the publication of articles on Scopus over the last thirty years. This shows that the high interest of the academic community towards research and the trends that are developing are very high.



a) Digital Learning

b) Mobile Learning

Fig. 2. Publication trend digital learning and mobile learning last thirty years

Figure 2 shows the number of articles in the field of digital learning and mobile learning at Scopus. Digital learning in 1992 only amounted to 9 documents. Then the increase occurred continuously which finally in 2021 the published articles had reached thousands, namely 1052 documents. Whereas mobile learning in 1992 only amounted to 6 documents. Then the increase occurred continuously which finally in 2021 the published articles had reached thousands, namely 1018 documents.

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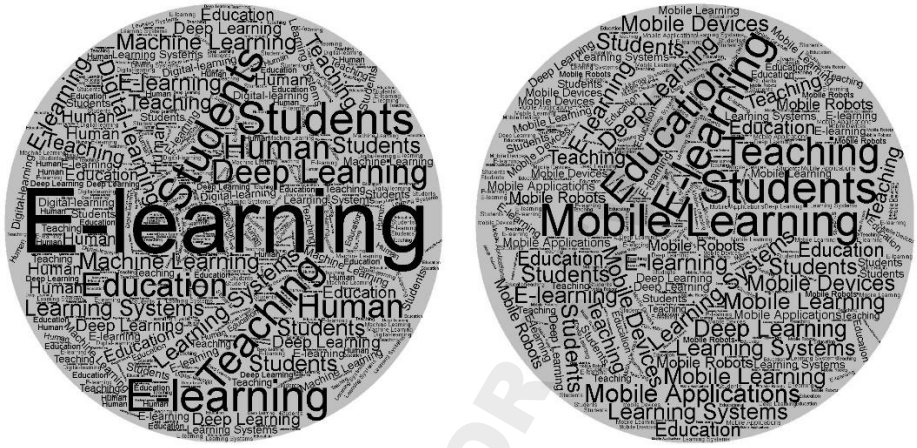
3.2 Visualization keyword of papers

The most frequently used keywords are graphically shown in Figure 3. Larger font sizes represent the frequency with which words are used the most. Words that are commonly used in digital learning are E-learning, students, human, teach, deep learning, etc. As for mobile learning, the words that are often used are mobile learning, students, E-learning, teaching, mobile application, education, etc.



a) Digital Learning **b) Mobile Learning**

Fig. 3. The most relevant keywords

From 1992 to 2021 there were 6148 Scopus indexed documents with the topic of digital learning. As for the topic of mobile learning from 1992 to 2021, there are 9481 documents. Then the researcher visualized the trend of the topic with the help of VOSViewer which is presented in Figures 3a and 3b. In addition, the brightest color indicates the most updated word related to the BDAG [37].

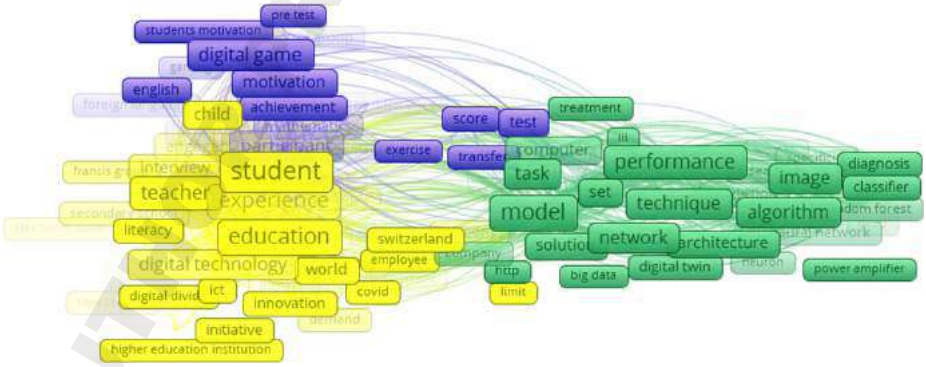


Fig. 4a. The network visualization relevance trend in digital learning

Based on Figure 4(a) the relevance trend in digital learning produces three visible color clusters (yellow, green, and purple). In the first cluster (yellow color) are student,

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education, limit, initiative, higher education institution, innovation, ict, covid, world, digital technology, employee, switzerland, literacy, teacher, experience, interview, and etc. The second cluster (green color) is model, http, big data, solution, task, computer, treatment, set, performance, technique, network, digital twin, architecture, algorithm, image, power amplifier, classifier, diagnosis, and etc. The third cluster (purple color) is test, transfer, exercise, score, achievement, motivation, digital game, english, pre test, students motivation, and etc. In addition, the lightest color indicates the most updated word related to the topics [37].

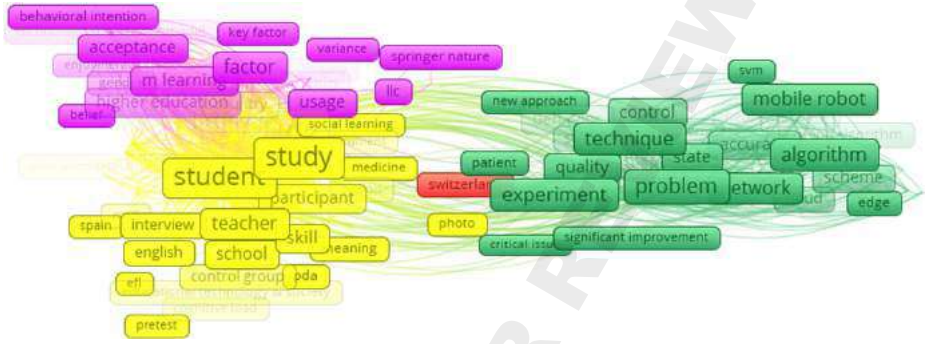

Fig. 4b. The network visualization relevance trend in mobile learning

Based on Figure 4(b) the relevance trend in digital learning resulted in four visible color clusters (yellow, green, purple, and red). In the first cluster (yellow color) are study, student, participant, teacher, skill, learning, school, pretest, english, spain, interview, control group, social learning, medicine, photo, and etc. The second cluster (green) is problem, critical issue, significant improvement, experiment, patient, quality, technique, new approach, control, state, network, algorithm, mobile robot, edge, and etc. The third cluster (purple) is usage, ilc, springer nature, variance, factor, key factor, m-learning, belief, higher education, acceptance, behavioral intention, and etc. Cluster four (red) is Switzerland.

3.3 Publication type

Table 2. Document type of top cited paper

Document Type	Frequency		Total Cited		Mean		Median		SD	
	DL	ML	DL	ML	DL	ML	DL	ML	DL	ML
Article	80	82	13544*	21680*	169.3	264.4	119.0	212.5	158.8	132.8
Conference Paper	8	11	872	2637	109.0	239.7	92.0	229.0	45.9	65.7
Book	6	2	905	666	150.5	333.0	129.0	333.0	61.8	79.2
Review	4	4	758	1363	189.0*	340.8*	204.0*	339.5*	95.7	103.2
Book Chapter	1	1	88	299	88.0	299.0	88.0	299.0		–
Editorial	1	–	363	–	363.0	–	363.0	–	–	–
Total	**100**	**100**	**16530**	**26647**	**1069.6**	**1477.9**	–	–	–	–

Note: *=the highest number.

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Document types from the top 100 papers published in digital learning and mobile learning from 1992 to 2021 can be seen in Table 2. The 100 papers for digital learning has six document types, namely, articles (80), Conference paper (8), Book (6), Review (4), Book Chapter (1), and Editorial (1). In addition, the highest and lowest average number of review citations are (363.0) and (88.0) respectively, with the highest standard deviation (158.8). Meanwhile, for 100 mobile learning papers, there are five types of documents, namely articles (82), conference papers (11), books (2), reviews (4), and book chapters (1). Furthermore, for the highest and lowest average number of review citations, respectively (340.0) and (239.0) with the highest standard deviation (132.8).

3.4 Distribution of top cited 100 paper

Table 3. Distribution paper

Digital Learning						Mobile Learning					
Year	**Paper**	**Citation**	**ACPP**	**HAPPY**	**City Year**	**Year**	**Paper**	**Citation**	**ACPP**	**HAPPY**	**Citable**
1992	1	95	95.0	3.2	30	1995	1	202	202.0	7.5	27
1995	2	215	107.5	4.0	27	1996	1	222	222.0	8.5	26
2001	2	414	207.0	9.9	21	1998	2	903	451.5	18.8	24
2004	2	450	225.0	12.5	18	2000	1	601	601.0*	27.3	22
2005	4	1219	304.8	17.9	17	2002	4	872	218.0	10.9	20
2006	2	261	130.5	8.2	16	2003	6	1368	228.0	12.0	19
2007	5	878	175.6	11.7	15	2004	2	471	235.5	13.1	18
2008	5	844	168.8	12.1	14	2005	2	614	307.0	18.1	17
2009	7	2253	321.9*	24.8	13	2006	1	160	160.0	10.0	16
2010	3	410	136.7	11.4	12	2007	8	2170	271.3	18.1	15
2011	7	904	129.1	11.7	11	2008	6	2364	394.0	28.1	14
2012	10	1298	129.8	13.0	10	2009	10*	2856*	285.6	22.0	13
2013	7	1159	165.6	18.4	9	2010	8	1923	240.4	20.0	12
2014	8	860	107.5	13.4	8	2011	7	2328	332.6	30.2	11
2015	4	420	105.0	15.0	7	2012	5	1870	374.0	37.4	10
2016	11*	2433*	221.2	36.9	6	2013	5	1445	289.0	32.1	9
2017	4	533	133.3	26.7	5	2014	5	986	197.2	24.7	8
2018	6	807	134.5	33.6	4	2015	2	390	195.0	27.9	7
2019	8	711	88.9	29.6	3	2016	8	2211	276.4	46.1	6
2020	2	274	137.0	68.5*	2	2017	7	1510	215.7	43.1	5
–	–	–	–	–	–	2018	4	774	193.5	48.4	4
–	–	–	–	–	–	2019	4	1181	295.3	98.4*	3
–	–	–	–	–	–	2020	1	225	225.0	112.5	2
Total	100	16438	3224.5	382.3		Total	100	27646	6409.8	715.2	

Notes: ACPP= Average Citation Per Paper, ACPPY= Average Citation Per Paper Per Year, *= the highest number.

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Based on the Table 3 above, for digital learning and mobile learning, publications do not occur every year. This can be seen in the years that have no paper at all. Furthermore, the top 100 articles on digital learning obtained a total of citations (16438) with an average of (3224.5) citations. The highest citation is (2433) in 2016, the highest average citation is (321.9) in 2009, and the highest average citation per paper per year is (68.5) in 2020. As for mobile learning, it gets a total of citations (27646) with an average (6409.8) citations. The highest citation is (2856) in 2009, the highest average citation is (601.0) in 2000, and the highest average citation per paper per year is (98.4) in 2019.

3.5 Top 10 authors with more articles

Table 4. Top 10 author with more article

Digital Learning			Mobile Learning		
Author	**Document**	**Country**	**Author**	**Document**	**Country**
Ifenthaler, D	15	Curtin University (Australia)	Hwang, GJ	70	National Taiwan University of Science and Technology (Taiwan)
Lam, EY	14	The University of Hong Kong (Hong Kong)	Huang, YM	39	National Cheng Kung University (Taiwan)
Chen, GD	13	National Central University(Taiwan)	Milrad, M	36	Linnaeus University (Sweden)
Barber, W.	12	Ontario Tech University (Canada)	Kukulska-Hulme, A	34	The Open University, Milton Keynes (United Kingdom)
Hwang, GJ	12	National Taiwan University of Science and Technology (Taiwan)	Wong, LH	34	National Institute of Education (Singapore)
Bandung, Y	11	Bandung Institute of Technology (Indonesia)	Traxler, J	30	University of Wolverhampton (United Kingdom)
Lee, JS	11	The Education University of Hong Kong (Hong Kong)	Looi, CK	29	Center for Research and Development in Learning (Singapore)
Erstad, O	9	Universitetet I Oslo (Norway)	Parsons, D	26	The Mind Lab, Auckland (New Zealand)
Huang, YM	9	National Cheng Kung University (Taiwan)	Sharples, M	26	The Open University, Milton Keynes (United Kingdom)
Sampson, DG	9	University of Piraeus (Greece)	Specht, M	24	Delft University of Technology (Netherlands)

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Table 4 shows the top 10 authors' articles with the highest number of documents from 1992 to 2021 from different countries. In digital learning, it is dominated by Ifenthaler, D from Curtin University (Australia) with a total of 15 documents, followed by Lam, EY from The University of Hong Kong (Hong Kong) with a total of 14 documents, and followed by Chen, G.D from National Central University(Taiwan) with the number of diemen (13). Meanwhile, for mobile learning, it was dominated by Hwang, GJ from the National Taiwan University of Science and Technology (Taiwan) with a total of (70) documents, followed by Huang, YM from National Cheng Kung University (Taiwan) with 39 documents, and followed by Milrad, M from Linnaeus University (Sweden) with the number of documents (36).

3.6 Top country of publication 100 highest

Table 5. Top countries 100 cited publication (1992–2021)

Digital Learning				Mobile Learning			
Country	**Article**	**Total Citation**	**Average Article Citation**	**Country**	**Article**	**Total Citation**	**Average Article Citation**
United States	33	6452	195.52	Taiwan	26	8308	319.54
United Kingdom	13	2120	163.08	United States	19	5658	297.79
Taiwan	7	584	83.43	United Kingdom	17	3166	186.24
China	5	435	87.00	Singapore	4	879	219.75
Netherlands	5	1532	306.40	South Korea	3	744	248.00
Australia	4	490	122.50	Switzerland	3	831	277.00
Belgium	4	423	105.75	Australia	3	646	215.33
Finland	4	598	149.50	China	3	626	208.67
Hong Kong	4	548	137.00	Japan	3	622	207.33
Canada	3	1187	395.67	Netherlands	2	373	186.50
Germany	3	475	158.33	Germany	2	400	200.00
South Korea	3	510	170.00	Italy	2	382	191.00
France	1	295	295.00	Turkey	2	353	176.50
Greece	1	984	984.00	Canada	2	400	200.00
Italy	1	74	74.00	South Africa	1	303	303.00
New Zealand	1	137	137.00	Nigeria	1	300	300.00
Norway	1	81	81.00	Hong Kong	1	285	285.00
Oman	1	292	292.00	Malaysia	1	213	213.00
Russian	1	77	77.00	Spain	1	196	196.00
Singapore	1	189	189.00	Portugal	1	180	180.00
Spain	1	305	305.00	Chile	1	170	170.00
Switzerland	1	105	105.00	Finland	1	163	163.00
Thailand	1	74	74.00	France	1	162	162.00
Turkey	1	71	71.00	–	–	–	–
Total	100	18038	4758.2	**Total**	**100**	**25277**	**5061.3**

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The calculation of the publication of articles from countries is only based on the affiliation that published the articles. Table 5 shows that there are country differences between the top 100 digital learning papers and the top 100 mobile learning papers. For digital learning, it shows that there are 24 different countries that have produced the top 100. The United States dominates the production of papers with (33) articles, followed by the United Kingdom (13), Taiwan (7), China and the Netherlands respectively (5), Australia, Belgium, Finland, and Hong Kong (4), respectively, Canada, Germany, and South Korea (3), and France, Greece, Italy, New Zealand, Norway, Oman, Russia, Singapore, Spain, Switzerland, and Thailand each (1) article for digital learning. As for mobile learning, it shows that there are 23 different countries that have produced the top 100 articles. Article publications are dominated by Taiwan (26), United States (19), United Kingdom (17), Singapore (4), South Korea, Switzerland, Australia, China, and Japan respectively (3), Netherlands, Germany, Italy, Turkey, and Canada (2) each, and South Africa, Nigeria, Hong Kong, Malaysia, Spain, Portugal, Chile, Finland, and France each (1) article for mobile learning.

3.7 Top 10 productive countries

When analyzing we found the leading countries that have the most publications on digital learning and mobile learning. Each of the top three countries that have the most publications during 1991 to 2021 are the United States (1354 doc), United Kingdom (456 doc), and China (407 doc) for digital learning which can be seen in Figure 5a. As for mobile learning, the top three countries that have the most publications during 1991 to 2021 are China (1390 docs), United States (1359 docs), and United Kingdom (659 docs) which can be seen in Figure 5b.

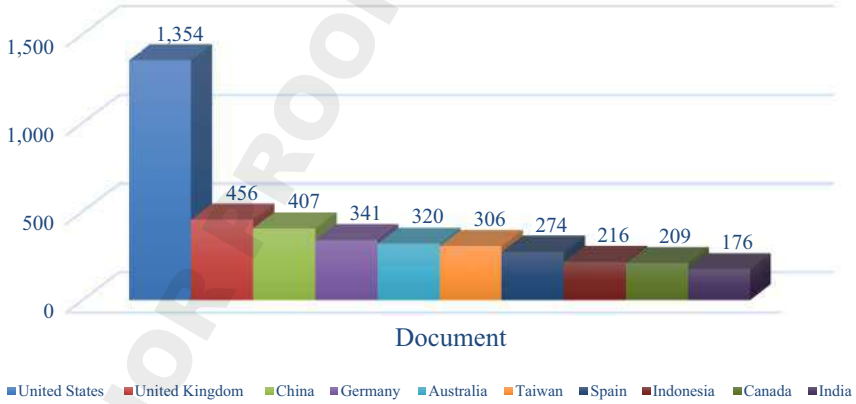

Fig. 5a. Top 10 productive countries digital learning

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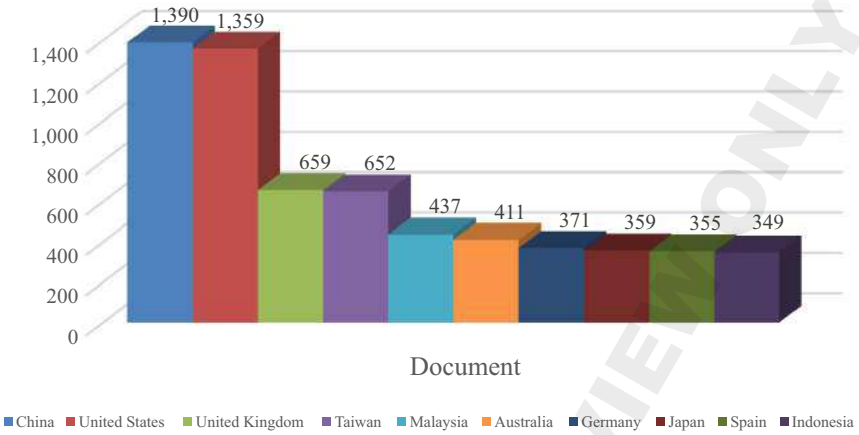

Fig. 5b. Top 10 productive countries mobile learning

3.8 The differences and similarities between digital learning and mobile learning

After reviewing literature and other scientific sources, facts are obtained which state that there are so many differences and similarities between digital learning and mobile learning. That way, it is important to discuss this so that it can reduce misconceptions about digital learning and mobile learning. For more details presented in Table 6.

Table 6. Differences and similarities digital learning and mobile learning

Description	Digital Learning	Mobile Learning
Understanding	Digital learning is a digital learning resource that includes many elements to be used in learning [32]	Mobile learning is a learning model that adopts the development of mobile technology and mobile devices (HP) as a learning medium [33]
Function	Facilitates the learning process and presents more interesting teaching materials [32]	As an alternative to mobile or mobile-based learning services [34]
Forms/types of	• Blended learning • Online Learning/E-learning • Use of technology (applications, google, and the like) • Adaptive learning	• Applications • Web
Existence	continues to grow	Continuously develops
Devices	HP, notebook, Tablet, PDA, Computer, Web, PC, TV, CD-ROM, and etc	Mobile, notebook, tablet, smartphone and PDAs.
Features	Video Streaming/live, virtual whiteboards, quizzes/virtual exams, discussion threads, online questionnaires, online TV, and etc [35]	Features that can be used Based on the type of application installed [36]

(*Continued*)

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Table 6. Differences and similarities digital learning and mobile learning (*Continued*)

Description	Digital Learning	Mobile Learning
Scope	Covers all bases digital	According to the specs of the device used
Approach	All media	Certain applications
Size	Flexible	According to device
Application	All applications	Limited applications
Place	Virtual Classroom online, teachers in class, and internet labs	Flexible learning (anywhere and anytime)
Access	Internet	Internet

Based on Table 6 shows the differences and similarities between digital learning and mobile learning. Lots of people say that digital learning and mobile learning are the same thing. Even though there are differences between the two things [38]. In addition, digital learning includes all what learning is contained in mobile learning. This is because learning that uses mobile learning must be in digital form, whether it be applications, e-books, web, and etc [34, 35, 36, 38]. However, digital learning has so many other devices such as computers, PCs, tablets, and etc [39]. While mobile learning is more dependent on applications, Google, and the web [36]. If illustrated, it will look like Figure 6.

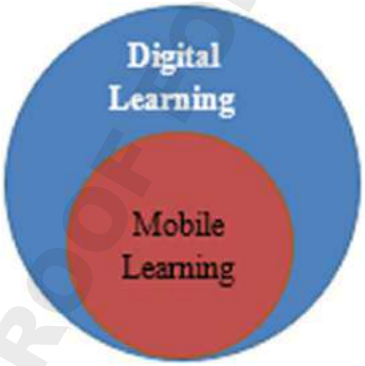

Fig. 6. Relationship illustration digital learning and mobile learning

3.9 The advantages and disadvantages of digital learning and mobile learning

The results of the study of literature and scientific sources related to the topic of digital learning and mobile learning obtained the fact that each of them has advantages and disadvantages in each field. For more details, see Table 7 below.

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Table 7. Advantages and disadvantages of digital learning and mobile learning

Digital Learning	Mobile Learning
Advantages	
• Relatively expensive according to the device used • Learning depends on the device used (for example, a computer should not be used while traveling while a tablet can be used anywhere) • Can eliminate some formal learning and make it more interesting • Types of wireless communication to access all information • Multiple delivery and content creation options • Facilitates both individual and collaborative learning experiences • helps provide and support literacy, numeracy and language learning • Can increase self-confidence in education • Increase skills in using technology in learning activities • Can have discussions without having to meet • Can use teaching materials as needed • Support distance • learning that develops in everyday life • Learning can be followed by more students	• Relatively inexpensive because it only uses certain • cellphones Learning can be done anywhere, anytime, and is personalized • Can eliminate some formal learning and make it more interesting • Types of wireless communication to access all information • Multiple delivery and content creation options • Facilitate learning experiences both individually and collaboratively • to help provide and support literacy, numeracy and language learning • Can increase self-confidence in education • Increase skills in using technology in learning activities • Can conduct discussions without having to meet • Can access teaching materials needed at any time and certainly more attractive • Easier to carry and use • Supports distance learning Take • advantage of emerging technologies in everyday life • Learning can be followed by more students
Disadvantages	
• Can only be used use by people who can afford • It Always need internet access • Quickly makes you bored because you don't see each other • Practical learning can't be done maximally • Depends on a good network • Development and learning is more about knowledge • Can't monitor students individually • Learning depends on device battery percentage • Abstract learning is very difficult to understand • The atmosphere must be conducive • Requires a lot of help tools such as, Pen Tab, webcam, a good headset.	• Can only be used by people who can afford • It always requires internet access • Limited with storage from the device used • Large practicum applications cannot be installed • Depends on a good network • Development and learning is more about knowledge • Cannot monitor students individually • Learning depends on HP battery percentage • Many mobile differences such as iOS, Android, and Apple that can only be used on certain cell phones • Atmosphere must be conducive • Small memory capacity • Small screen view

Based on Table 7 shows the advantages and disadvantages of digital learning and mobile learning. Digital learning and mobile learning are learning alternatives that are growing rapidly in line with technological developments. In addition, the COVID-19 pandemic is still ongoing so that learning is shifted to online. There are advantages and disadvantages to each of the learning carried out as written in Table 5. Actually digital learning has been popularized since 1960 by the University of Illinois with the aim only to convey information to students. However, along with the development of technology, digital learning continues to grow rapidly so that it is often used in learning

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including e-books, e-modul, PPT, and etc [32][41–43]. In this way, new innovations such as e-learning, blended learning, and mobile learning emerge.

3.10 Research implication

- To Researcher, can be the basis for further research in the field of digital-based implementation which has similarities but is in fact different. In addition, you can find out trends in digital-based learning that are in accordance with certain conditions, both nationally and internationally.
- To Librarian, can be a source of new research and knowledge related to the development of digital-based learning in an increasingly advanced era with technology
- To Policymakers, can provide sources of information on digital research topics that are growing rapidly so that they can make decisions with certain considerations based on valid information obtained.

4 Conclusion

Digital learning and mobile learning are two different things but still have something in common. Learning with mobile learning is an innovation from digital learning. Based on Scopus data from 1992 to 2021, digital learning and mobile learning publications have on average experienced a significant increase. This is due to following technological developments and due to the ongoing COVID-19 pandemic. Based on the results that have been presented, it can be seen the trends, differences, similarities, advantages, and disadvantages of digital learning and mobile learning. Thus, it is hoped that this discovery can be a reference for future discoveries in aspects of digital-based learning.

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[iJIM] Editor Decision

Michael Auer via Online-Journals.org <noreply@journals.publicknowledgeproject.org> Thu, Feb 24, 2022 at 5:23 PM
Reply-To: Michael Auer <auer@cti-online.net>
To: "Dr. Binar Kurnia Prahani, M.Pd." <binarprahani@unesa.ac.id>, Mohd Zaidi Bin Amiruddin <Mohdzaidi.19079@mhs.unesa.ac.id>, "Prof. Dr. Budi Jatmiko, M.Pd." <budijatmiko@unesa.ac.id>, "Assoc. Prof. Nadi Suprapto, Ph.D." <nadisuprapto@unesa.ac.id>, "Tan Amelia, S.Kom., M.MT." <meli@dinamika.ac.id>
Cc: Michael Auer <auer@cti-online.net>

Dr. Binar Kurnia Prahani, M.Pd., Mohd Zaidi Bin Amiruddin, Prof. Dr. Budi Jatmiko, M.Pd., Assoc. Prof. Nadi Suprapto, Ph.D., Tan Amelia, S.Kom., M.MT. :

We have reached a decision regarding your submission to International Journal of Interactive Mobile Technologies (iJIM), "Top 100 Cited Publications for The Last Thirty Years in Digital Learning and Mobile Learning ".

Our decision is to: Accept Submission

Congratulation to your fine work.
The reviewers haven't had major recommendations for the submission's narrative.
The paper is ready for publishing.
You will receive an invoice for the APC by separate email.
Editorial Team

International Journal of Interactive Mobile Technologies (iJIM) – http://www.i-jim.org

Binar Kurnia Prahani <binarprahani@unesa.ac.id>

iJIM Invoice

2 messages

CTI Office <office@cti-online.net> Thu, Mar 3, 2022 at 3:17 AM
To: binarprahani@unesa.ac.id

Dear author,

Please find attached to this e-mail the invoice for your iJIM Article Processing Charges (APC). Once printed, it will be identical to an invoice sent through postal mail. Payment is expected within 10 days from reception of this invoice on. Payment can be made by *bank transfer*, *PayPal* or *credit card* (via PayPal, no account needed).

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For payments by bank transfer, please find the details in the attached invoice.
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Best regards,
CTI Office

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Binar Kurnia Prahani <binarprahani@unesa.ac.id> Thu, Mar 3, 2022 at 6:23 AM
To: saiyidah_pfis@ulm.ac.id

Best Regards,

Binar Kurnia Prahani
Universitas Negeri Surabaya

IJORER : International Journal of Recent Educational Research : https://journal.ia-education.com/index.php/ijorer

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Binar Kurnia Prahani <binarprahani@unesa.ac.id>

[iJIM] [29803] Editor Decision

1 message

Michael Auer via Online-Journals.org <noreply@journals.publicknowledgeproject.org> Thu, Mar 3, 2022 at 3:53 PM
Reply-To: Michael Auer <auer@cti-online.net>
To: "Dr. Binar Kurnia Prahani, M.Pd." <binarprahani@unesa.ac.id>, Mohd Zaidi Bin Amiruddin <Mohdzaidi.19079@mhs.unesa.ac.id>, "Prof. Dr. Budi Jatmiko, M.Pd." <budijatmiko@unesa.ac.id>, "Assoc. Prof. Nadi Suprapto, Ph.D." <nadisuprapto@unesa.ac.id>, "Tan Amelia, S.Kom., M.MT." <meli@dinamika.ac.id>

Dr. Binar Kurnia Prahani, M.Pd., Mohd Zaidi Bin Amiruddin, Prof. Dr. Budi Jatmiko, M.Pd., Assoc. Prof. Nadi Suprapto, Ph.D., Tan Amelia, S.Kom., M.MT. :

The editing of your submission, "Top 100 Cited Publications for The Last Thirty Years in Digital Learning and Mobile Learning ," is complete. We are now sending it to production.

Changes to the paper are no longer possible. You will receive a proof in good time prior to publication.
The paper is expected to be published in iJIM issue 07 in April.

Submission URL: https://online-journals.org/index.php/i-jim/authorDashboard/submission/29803

International Journal of Interactive Mobile Technologies (iJIM) – http://www.i-jim.org

Binar Kurnia Prahani <binarprahani@unesa.ac.id>

[iJIM][29803][Proof Announcement] Top 100 Cited Publications for The Last Thirty Years in Digital Learning and Mobile Learning

1 message

Sebastian Schreiter <sschreiter07@gmail.com> Thu, Mar 24, 2022 at 11:44 PM
To: binarprahani@unesa.ac.id
Cc: Mohdzaidi.19079@mhs.unesa.ac.id, budijatmiko@unesa.ac.id, nadisuprapto@unesa.ac.id, meli@dinamika.ac.id

Please read this email carefully – all of the below is important.

Dear Dr. Prahani,

your paper is now scheduled in iJIM, Vol. 16, No. 08, 2022 to be published around 26 April 2022.

— Your final version is now being formatted – DO NOT UPLOAD OR SEND ANOTHER VERSION, it cannot be taken into account.
— You are receiving this email because (according to the metadata in the system) you are the corresponding author (primary contact). However, the proof will be sent to the corresponding author given in the paper.
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Thank you for working with us!
Sebastian Schreiter

Technical Editor
online-journals.org

Binar Kurnia Prahani <binarprahani@unesa.ac.id>

iJIM_29803: Page proof

2 messages

Vijayakumar Revathy <revathy@online-journals.org> Mon, Apr 4, 2022 at 2:11 PM
To: "binarprahani@unesa.ac.id" <binarprahani@unesa.ac.id>

Dear Author,

Thank you for your work on *International Journal of Interactive Mobile Technologies*. Attached is one set of page proofs of your article. Please make special note of any queries included in your PDF. We must have answers to these queries before considering the article finalized.

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Thanking you!
Revathy

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Binar Kurnia Prahani <binarprahani@unesa.ac.id> Mon, Apr 4, 2022 at 2:44 PM
To: Vijayakumar Revathy <revathy@online-journals.org>

Dear Editor

Thanks for your information

Best Regards,

Binar Kurnia Prahani
Universitas Negeri Surabaya

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Binar Kurnia Prahani <binarprahani@unesa.ac.id>

Re: iJIM_29803: Revised proof

2 messages

Vijayakumar Revathy <revathy@online-journals.org> Wed, Apr 13, 2022 at 1:07 PM
To: Binar Kurnia Prahani <binarprahani@unesa.ac.id>

Dear Author,

Please find attached the updated proof for your approval!

Regards
Revathy

> On 04/04/2022 9:44 AM Binar Kurnia Prahani <binarprahani@unesa.ac.id> wrote:
>
> Dear Editor
>
> Thanks for your information
>
> **Best Regards,**
>
> **Binar Kurnia Prahani**
> **Universitas Negeri Surabaya**
>
> On Mon, Apr 4, 2022 at 2:11 PM Vijayakumar Revathy <revathy@online-journals.org> wrote:
>
> > Dear Author,
> >
> > Thank you for your work on *International Journal of Interactive Mobile Technologies*. Attached is one set of page proofs of your article. Please make special note of any queries included in your PDF. We must have answers to these queries before considering the article finalized.
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Thanking you!
Revathy

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Binar Kurnia Prahani <binarprahani@unesa.ac.id> Wed, Apr 13, 2022 at 4:08 PM
To: Vijayakumar Revathy <revathy@online-journals.org>

Dear Editor,

Thanks for your information

Best Regards,

Binar Kurnia Prahani
Universitas Negeri Surabaya

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