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Online and Distance Learning Research in The Last 30 Years: Real Contribution in Physics Learning

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Abstract

Learning systems in emergencies, can be implemented by making online-based learning or distance learning. This study compares the top 100 citations of online learning and distance learning publications and analyzes their real contribution in physics learning from 1992 to 2021. This study uses bibliometric analysis and literature review. The findings of this study include: 1) The trend of online learning topics is more consistently rising and has a higher value than distance learning every year, 2) The most frequently used keywords are online learning, and distance metrics learning, the United States has the highest contribution over the last thirty years, 3) The type of document that is often used is articles, 4) The highest average citation per paper per year is in 2020, 5) Both topics demonstrate the superiority of contributions to studying physics. The real contributions in physics are to make learning more flexible, train students' independence, train technology, deepen understanding of concepts and make learning more efficient. More intensively, further research can be done by comparing other learning systems applied in physics learning.

Keywords: Online Learning; Distance Learning; Physics Learning

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INTRODUCTION

The advancement of the technological era that is happening at this time has a positive impact on the world of education, some examples of the implementation of technology are implied in online learning, distance learning, and others. The development of learning systems must pay attention to the ease of adaptation and transformation (Huei, 2014; Dias et al., 2021; Hui et al., 2022). Learning development can be done by combining organizational learning theory and general systems theory (Oksana et al., 2022). Learning must be continuous and flexible even in unforeseen conditions (Youness et al., 2018).

In 2019, a disaster hit the world, namely the covid-19 pandemic, education is one of the things that feels its impact. One of the updates on October 10, 2021, the whole country reported 219 million cases with 4.55 million deaths (Hassan, 2022). With the dangers looming, many countries are trying to make learning sustainable (Cristine et

al., 2022). Efforts are being made to organize healthy learning during the covid-19 pandemic crisis (Sandi et al, 2020). The covid-19 outbreak caused the closure of schools and colleges, so educational institutions designed online learning. Research conducted by Anas et al., (2022); Chamdani et al., (2022); and Djuwandi et al., (2022) stated that during the covid-19 pandemic, student responses showed good acceptance of online learning. Online learning that utilizes digital technology can be done either face to face or without face to face. For non face-to-face learning, it is defined as distance learning. Students accept and adapt quickly to distance learning during the covid-19 pandemic (Hamdi & Ehsan, 2022).

Physics learning is closely related to natural phenomena and experimental activities. Interesting and interactive physics learning can be done in or outside classroom (Poluakan & Katuuk, 2021). The important role of interactive physics learning through online learning is that students are challenged to be more independent, disciplined, and responsible for themselves (Geoffrey et al., 2019; Kustijono et al., 2020; Herry et al., 2021). However, there are shortcomings in the implementation of non-face-to-face learning, namely the lack of social training due to assignments that tend to be individual and the potential for dependence on digital technology (Amab & Tripti, 2021; Pavin, 2022). Physics teachers' assistance and supervision will determine the success of online learning (Surahman & Sujarwanto, 2020; Ahmad et al., 2021).

The problems include there is still no discussion from existing studies that compare online and distance learning. Some studies tend only to discuss online learning. Bibliometric studies and literature reviews are needed to show the correct data regarding the comparison. Bibliometric analysis is a method to provide knowledge regarding the growth and flow of literature in a particular publication field (Hashim et al., 2018). This bibliometric study uses empirical data to track existing publications (Estabrooks et al., 2004; Jose et al., 2018; Rolland, 2020; Dewantara et al., 2021). This study can analyze the distribution of manuscripts sorted by country, source, year, and more (Tsay & Shu, 2011; Rani, 2019; Fernandes & Cortez, 2020; Ishamuddin et al., 2021; Lam et al., 2022). With an explanation of the importance of online, and distance learning and the existing shortcomings, this research was carried out.

The objective research includes analysis using bibliometrics and also a literature review. The aim is to compare the top 100 highest citations of publications on online and distance learning and analyze the real contribution in physics learning from 1992 to 2021. This study uses data over a period of thirty years because to find out the trend of a topic it is more accurate if the data collection is viewed over a longer time span than using only five or ten years of data. In addition, data collection in the last thirty years can also show differences in the existence of topics before and after the covid-19 pandemic, differences in the author's point of view will be seen more clearly and the contribution of the topics raised will appear wider. The research questions include:

1. What are the trend of online and distance learning publications from the last thirty years?
2. What are the most used keywords, countries and authors who have contributed the most to online and distance learning publications in the last thirty years?
3. What are the highest source document types and titles for online and distance learning publications of the last thirty years?

4. How does the year-by-year distribution of the 100 online and distance learning publications cited from the last thirty years compare?
5. How do online and distance learning compare to the real contribution of physics learning over the last thirty years?
6. How do online publications and distance learning compare with their similarities, differences, advantages and disadvantages?

METHOD

Research Design

This study uses bibliometric analysis and literature review. The data used in this study were taken from Scopus. Scopus is well-known for its most extensive database of publications in various fields, including academics (Tavukcu et al., 2020; Jiaxing et al., 2021; Mohamad et al., 2022). Data from Scopus can be adjusted according to the needs of the year, title, country, keywords, and so on (Genc et al., 2019; Nurdin et al., 2020; Kulkanjanapiban & Silwattananusam, 2022). In addition, this study uses a literature review from previous studies as a reinforcement of research data (Girwidz et al., 2019).

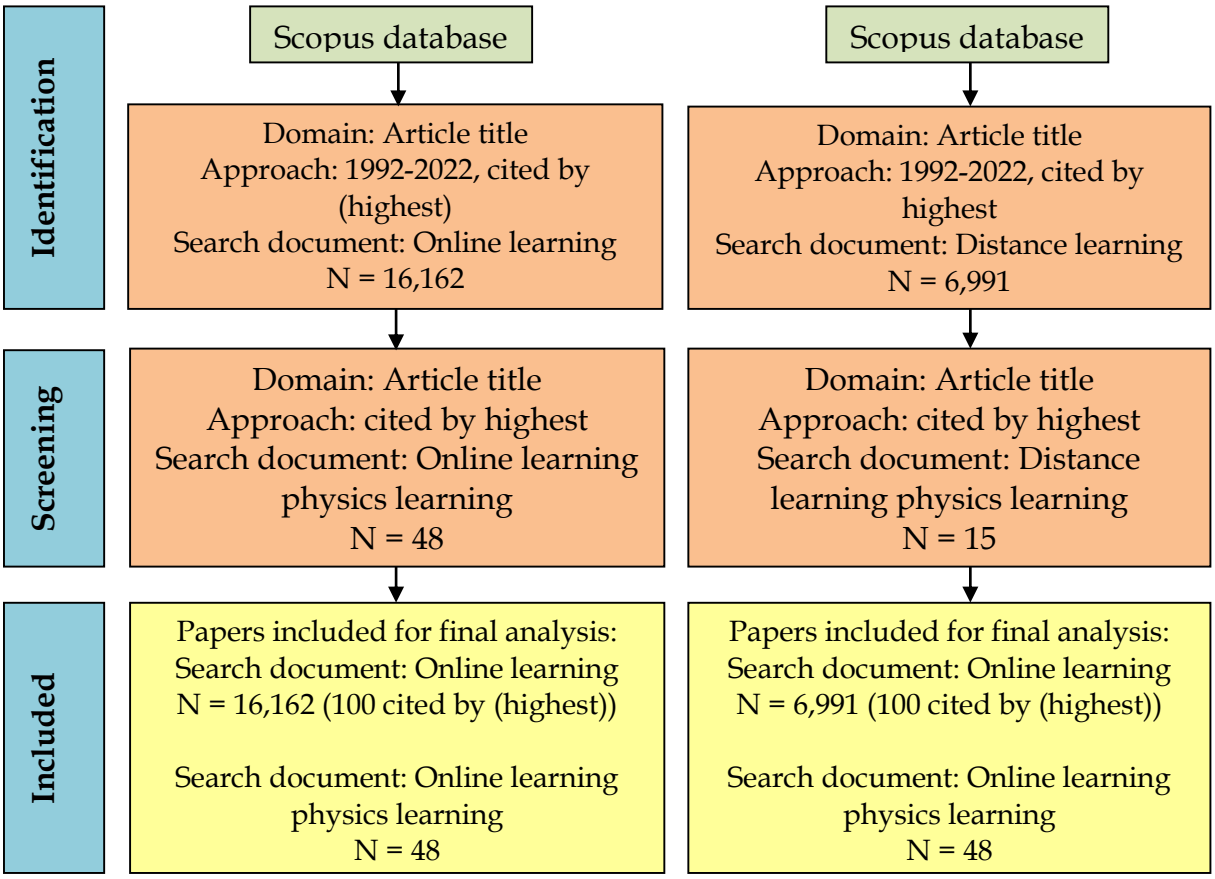


Figure 1. Flowchart Research. Source: Modified from (Moher et al., 2010).

Sample and Data Collection

Research data were taken on April 1, 2022. The data in Scopus is selected based on the keywords we want to search. Data samples were taken using titles with keywords with a time span of the last thirty years from 1992 to 2021. The keyword selection stage was carried out twice in this study, the first regarding online learning,

and distance learning. Furthermore, the second keyword is connected with physics learning to find the real contribution of each online learning, and distance learning. For more details regarding keyword filtering, see Figure 1.

Analyzing of Data

This study uses two stages of analysis, namely bibliometrics and literature review. Data obtained from Scopus in .csv format which was analyzed using Microsoft excel, and data in .ris form which was analyzed using VOS viewer (Putri et al., 2021). Literature review is carried out to study, understand, and interpret existing studies on the same topic.

RESULTS AND DISCUSSION

The Publication Trend in the Last 30 Year

Figures 2a and 2b show the trend of publications related to online and distance learning. The publication trend is an important aspect to pay attention to and follow up (Nishioka & Farber, 2020). Considering that publications must follow current conditions, the development of a topic is determined by the trend of publications each year.

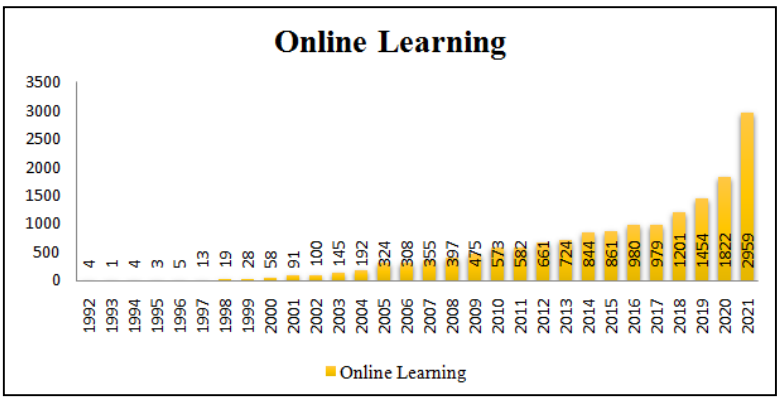


Figure 2a. Online learning publication trends

The highest online learning publication in 2021 was 2959 documents, and the lowest in 1993 was 1 document. Online learning publications have started to increase again from 2018 to 2021 steadily. The highest increase occurred in 2021 as many as 1137 documents from 2020. Publications on this topic decreased four times in the last 30 years.

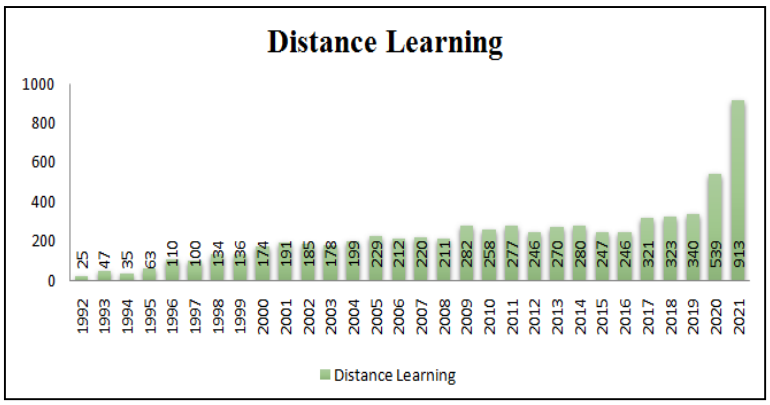
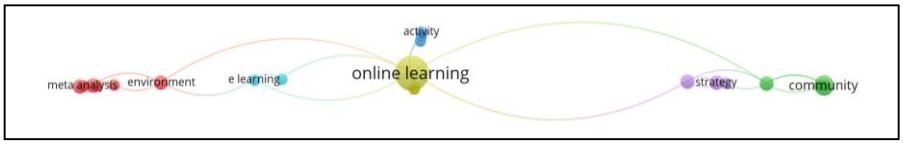


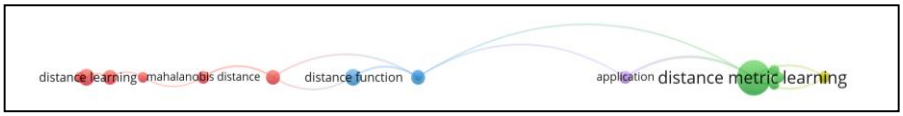
Figure 2b. Distance learning publication trends

Distance learning publications have started to increase again from 2018 to 2021 steadily. The highest increase occurred in 2021 as many as 374 documents from 2020. The highest online learning publication in 2021 was 913 documents, and the lowest in 1992 was 25 documents. Publications on this topic decreased ten times in the last 30 years.

Visualization of the Most Used Keywords, Top Countries, and Top Authors Who Contributed The Most



(a)



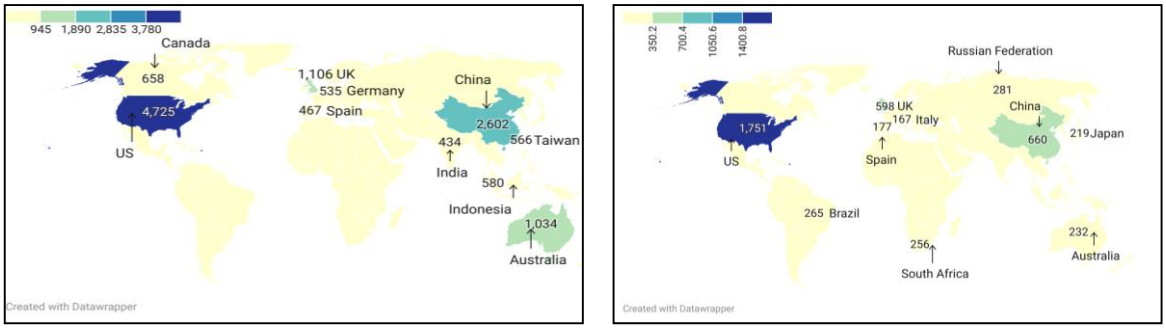
(b)

Figure 3. The keywords visualization of a) online learning, b) distance learning

From Figure 3, we can see the keyword visualization using VOS viewer. Keywords can describe the subject matter (Kulakli & Osmanaj, 2020; Jusoh et al., 2021). The most commonly used keyword is "online learning," which has 17 occurrences for online learning topics. For the topic of distance learning, the most commonly used keyword is "distance metric learning," which has 21 occurrences.

Table 1. Comparison of the top 10 countries with the most publications in the last thirty years

Number	Online Learning	Distance Learning
1	United States (n = 4,725)	United States (n = 1,751)
2	China (n = 2,602)	China (n = 660)
3	United Kingdom (n = 1,106)	United Kingdom (n = 598)
4	Australia (n = 1,034)	Russian Federation (n = 281)
5	Canada (n = 658)	Brazil (n = 265)
6	Indonesia (n = 580)	South Africa (n = 256)
7	Taiwan (n = 566)	Australia (232)
8	Germany (n = 535)	Japan (219)
9	Spain (n = 467)	Spain (n = 177)
10	India (n = 434)	Italy (167)
n = Total Publication		



(a) (b)

Figure 4. Top 10 Countries with publications about a) online learning, b) distance learning

From Table 1 and Figure 4. it can be concluded that the United States has made the highest contribution over the last thirty years to online and distance learning. Five countries consistently occupy the top 10 on all publication topics related to online and distance learning, including the United States, China, the United Kingdom, Australia, and Spain. To identify the author who has the most publications on online and distance learning, using VOS viewer and Microsoft Excel analysis. The results of the Microsoft Excel analysis are shown in Table 2.

Table 2. The top 10 authors with the highest citations in the last thirty years

Online Learning			Distance Learning		
Author	**TC**	**Country**	**Author**	**TC**	**Country**
J.C. Duchi	10,012	United States	K.Q. Weinberger	25,260*	United States
B. Perozzi	5,451	United States	E.P. Xing	17,621	United States
J. Mairal	13,334	France	J.C. Blitzer	6,330	United States
B. Babenko	4,737	United States	J.L. Moore	1,509	United States
S.J. Belongie	50,317*	United States	S. Ding	667	China
N. Liang	1,932	Singapore	A. Mingnon	539	France
J. Mairal	13,334	France	E.S. Ristad	534	United States
M.D. Hoffman	7,244	United States	J. Webster	7,916	Canada
J.C. Richardson	2,959	United States	E.L. Newport	11,771	United States
S.S. Shwartz	9,595	Israel	S. Xiang	7, 691	China

*TC = Total Citations *The Highest Number*

From the results of Table 2. it is known that the top 10 authors with the highest citations for the topic of online learning are J.C. Duchi from the United States. For the topic of distance learning, namely K.Q. Weinberger from the United States. Meanwhile, S.J. Belongie, and K.Q Weinberger owned the highest total citation and

where the both researchers came from, the United States. To find out who the author on online and distance learning is most contributing and connected is using VOSviewer. With VOSviewer, we can identify the classification of top authors (Alsuraihi, 2022). The grouping and connection of each author are indicated by the presence of clusters (Jatmiko et al., 2021). The first result of the online learning topic is divided into 3 clusters, namely red (n=3), green (n=2), and blue (n=1). J. Mairal is the main author because he has three documents with nine total link strengths than any other author. The following result of distance learning is divided into 2 clusters, namely red (n=2) and green (2). D. Tao is the main author because he has six documents with four total link strengths, more than any other author.

The Document Types and Source Titles of Top 100 Highest Cited Publications in the Last 30 Years

Table 3. The document types of the top 100 highest cited publications in the last 30 years

Document Type	Frekuensi		Cited		Mean		Median		SD	
	OL	DsL	OL	DsL	OL	DsL	OL	DsL	OL	DsL
Article	75*	66*	32249*	14577*	429.9	220.8	294	140	579.7	311.7*
Conference paper	18	28	12725	7796	706.9*	278.4	326.5	170	955.8*	275.4
Review	5	3	2266	393	453.2	131	443	144	227.5	36.2
Note	1	0	547	0	547	0	547*	0	-	-
Book	1	2	216	591	216	295.5*	216	295.5*	-	144.9
Editorial	0	1	0	238	0	238	0	238	-	-

OL=Online Learning DsL=Distance Learning
*SD=Standar Deviation *The Highest Number*

From Table 3 it can be seen that on all topics, both online and distance learning, most publications are in the form of articles. Wherefrom the whole of each topic with a total of 100 documents, it was found that online learning (n=75), and distance learning (n=66). Of the both topics, the highest citation was owned by online learning (n=32,249) in the form of articles. The standard deviation of the two topics is quite high, namely online learning (n=955.8) in the form of conference papers, and distance learning (n=311.7) in the form of articles.

Table 4. The source titles of the top 100 highest cited publications in the last 30 years

Online Learning			Distance Learning		
Source Title	TD	TC	Source Title	TD	TC
Internet and Higher Education	10	3586	Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition	6	1760
Journal of Machine Learning Research	9	9232	Advances in Neural Information Processing Systems	5	3127

Online Learning			Distance Learning		
Source Title	**TD**	**TC**	**Source Title**	**TD**	**TC**
Computers and Education	8	2469	Pattern Recognition	5	1356
Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition	5	2883	Computers and Education	4	476
Distance Education	5	1562	Open Learning	4	463
Computers in Human Behavior	4	995	IEEE Transactions on Education	3	557
International Review of Research in Open and Distance Learning	3	1056	Distance Education	3	323
British Journal of Educational Technology	3	791	Journal of Machine Learning Research	2	2743
IEEE Transactions on Knowledge and Data Engineering	3	722	Language Learning and Technology	2	297
Journal of Asynchronous Learning Network	2	1155	Language Learning and Technology	2	297
TD = Total Documents TC = Total Citations					

Table 4. shows that the source titles between online and distance learning are varied. For the highest source titles, online learning, namely Internet and Higher Education (n=10 documents), and distance learning, namely Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition (n= six documents).

Comparison of the Year Wise Distribution of Top 100 Highest Cited Publications in the Last 30 Years

Table 5. The year-wise distribution of the top 100 highest cited publications in the last 30 years

Year	Citable Year	Online Learning				Distance Learning			
		TC	**TD**	**ACPP**	**ACPPY**	**TC**	**TD**	**ACPP**	**ACPPY**
1992	30	0	0	0	0	0	0	0	0
1993	29	0	0	0	0	0	0	0	0
1994	28	0	0	0	0	0	0	0	0
1995	27	0	0	0	0	0	0	0	0
1996	26	0	0	0	0	306	1	306	11.7
1997	25	277	1	277	11.1	495	1	495	19.8
1998	24	0	0	0	0	514	1	514	21.4
1999	23	0	0	0	0	316	2	158	6.9
2000	22	329	1	329	14.9	998	6	166.3	7.6
2001	21	1128	3	376	17.9	803	6	133.8	6.3
2002	20	268	1	268	13.4	89	1	89	4.4

Year	Citable Year	Online Learning				Distance Learning			
		TC	TD	ACPP	ACPPY	TC	TD	ACPP	ACPPY
2003	19	853	1	853	448	2943	11*	267.5	14.1
2004	18	2037	5	407.4	22.6	1588	9	176.4	9.8
2005	17	2369	7	338.4	19.9	1982	4	495.5	29.1
2006	16	2216	3	738.6	46.2	647	4	161.7	10.1
2007	15	520	2	260	17.3	453	3	151	10.1
2008	14	444	2	222	15.9	997	5	199.4	14.2
2009	13	7505	18*	416.94	32.1	3149*	6	524.8*	40.3
2010	12	6833	14	488.1	40.7	393	3	131	10.9
2011	11	9732*	9	1081.3	98.3	1149	5	229.8	20.9
2012	10	1854	7	264.8	26.5	2043	7	291.8	29.1
2013	9	435	4	108.7	12.1	228	2	114	12.7
2014	8	5091	4	1272.7*	159.1	995	6	165.8	20.7
2015	7	2048	8	256	36.5	645	2	322.5	46.1
2016	6	202	1	202	33.6	577	3	192.3	32.1
2017	5	1010	4	252.5	50.5	626	4	156.5	31.3
2018	4	737	3	245.6	61.4	423	3	141	35.2
2019	3	0	0	0	0	761	3	253.6	84.5
2020	2	683	2	341,5	170.7*	475	2	237.5	118.7*
2021	1	0	0	0	0	0	0	0	0

*TC=Total Cited TD=Total Document ACPP= Average Citation Per Paper ACPPY= Average Citation Per Paper Per Year *The highest number*

Table 5. contains information on the distribution of the top 100 cited publications on online and distance learning. The range of data used is from 1992 to 2021. This information can be used to see in what year the top 100 cited publications were produced on each topic. From this study, it was found that the highest years included: 2009 (n=18 documents) for online learning publications; 2003 (n=11 documents) for distance learning publications. In addition, from this study it was found that the highest years included: 2011 (n=9,732 citations) for online learning publications; 2009 (n=3.149) for distance learning publications.The highest average citation per paper per year is in 2020 where online learning (n = 170.7); and distance learning (n=118,7).

Comparison of Online and Distance Learning

Table 6. Comparison of online and distance learning

Comparison	Online Learning	Distance Learning
Meaning	The teaching and learning process utilizes the internet and digital media to deliver the material.	They are learning program with independent learning methods (teachers and students are in separate locations), where students will be supported by curriculum and teaching materials.
Characteristics	• Computer-based media	• Teachers and students are not in the same place

Comparison	Online Learning	Distance Learning
	• Learning resources from websites, the internet, CD-ROM, etc • it can still be done even face to face	• The delivery of the learning process is carried out by utilizing communication and information media. • Emphasizing on independent learning, but some institutions regulate it
Advantage	Various learning media, up-to-date information, lower costs, and easier exchange of ideas	Flexibility in the learning process and lower costs for both distance education providers and students.
Disadvantage	Students who have limited internet access or unstable networks will find it challenging to carry out online learning.	Slow down the process of building social relations and low control over the learning process

It can be seen from Table 6 and with the majority of students in the 21st century are proficient in advanced technology and are adaptable. For example, online learning with interactive simulations positively affects student physics learning outcomes (Sunaryo et al., 2021). In addition, the use of interactive modules is also very important to apply because, according to research (Roza et al., 2021), online learning of physics with interactive modules shows compatibility and a positive impact. So that the important role of using interactive media in physics is to improve students' abilities, one of which is the ability to think critically (Wibowo et al., 2021).

Online and distance learning have similarities and advantages in flexibility and types of media that utilize sophisticated digital tools. A more visible difference is between online learning and distance learning. With online learning, teachers and students can face to face in class, but distance learning teachers and students are in faraway spaces and places (Kanbul et al., 2020; Masalimova et al., 2022).

Table 7. The top 10 highest cited papers showed the real contribution of online and distance learning to physics learning

Author	SJR	Citation	Findings	Recommendations
			Online Learning	
Hill et al., (2015)	0,42 (Q2)	43	Online learning modules (OLMs) in physics learning can improve students' understanding of concepts and easily represent physics material.	Further testing of the validity of the trial results will be needed, and then distributed OLMs more widely so that students can feel its benefits more broadly.
Klein et al., (2021)	1,14 (Q1)	26	By using online learning, it was found that students were more independent.	It is recommended to compress the indicators of competency achievement so that the

Author	SJR	Citation	Findings	Recommendations
			Still, the duration of physics learning was reduced, which impacted the effectiveness of material delivery.	delivery of the material remains effective, and further research is needed on this.
Faulconer et al, (2018)	1,03 (Q1)	11	Students who receive online learning have a higher level of understanding than students who take classes through face-to-face classes. Student learning outcomes are low for students who take courses in person rather than online.	It is recommended to conduct further research to explore why student learning outcomes online are higher than face-to-face.
Moradi et al., (2018)	0,45 (Q2)	7	Developing interactive instructional modules through online learning has a unique and effective result to help students achieve physics learning goals.	This requires further research whether interactive instructional modules can be used for all physics materials or only specific materials.
Marcal et al., (2020)	0,22 (Q3)	3	Online learning using interactive video annotations for physics learning affects students' interest and learning achievement for the better than before.	They should describe the form and process of developing and validating the interactive media in more detail.
Distance Learning				
Jonsson, (2005)	0,57 (Q2)	23	Distance learning integrating medical physics can increase students' interest in learning physics and applied physics.	Research with this approach can be applied to the training of engineering students and various fields of physics learning applications so that professional development can be sustainable in various fields.
Pandiangan et al., (2017)	0,42 (Q2)	21	With the distance learning system and the application of the	Further research can be carried out with other models besides PIL

Author	SJR	Citation	Findings	Recommendations
			Physics Independent Learning (PIL) model, an increase in students' post-test scores is obtained.	
Bodegom et al., (2019)	0,41 (Q2)	9	Distance learning with IOLab in physics learning impacts students' attitudes and learning outcomes through post-course shows positive results.	Referring to the article's findings showing that IOLab is effectively applied, it is recommended that it be adapted for physics learning in Indonesia.
Efwinda and Mannan, (2021)	0,21 (Q4)	1	The results showed a significant difference between student learning outcomes in physics learning by teachers who applied distance learning and those who did not. Teachers have difficulty implementing distance learning due to a lack of computer operating skills.	Based on the advantages of implementing distance learning and the existing obstacles, it is recommended to hold computer training for teachers regularly.
Saraiva et al., (2015)	0,2 (Q3)	0	Distance learning is effective to do in physics learning astronomy material.	Distance learning which is more effective in physics learning, needs to be spread more widely.

Table 7. contains the results of the literature review by taking into account the quartiles, citations, and findings to provide recommendations regarding the selected paper. The papers selected in Table 7 show the top 10 papers with the highest citations on each relevant topic from the total top 100 papers. The ranking system of reputable journals based on the subject or category of the related journal field is also called quartiles (Arianto & Basthomi, 2021). From these results, it can be seen that the topic of distance learning has the lowest citation average, thus, research related to distance learning in physics will have a lot of potentials, and its novelty will be quite high. The highest contribution to learning physics is with the topic of online learning. Online learning tends to take advantage of interactive learning applications to increase student motivation and learning outcomes (Ngah et al., 2022).

Since the last three years, the world has been affected by the pandemic, so academic units must also think about effective distance learning methods that can still improve student achievement. Therefore, interactive learning in physics is starting to be more widely applied (Ametepe & Khan, 2021). One of them is by using interactive multimedia, which is able to improve students' understanding of concepts (Susilowati

et al., 2021). Interactive learning plays an important role in deepening the concept of physics and making the learning atmosphere more interesting even though distance learning (Wongsuwan et al., 2022).

CONCLUSION

Research results analysis using bibliometric studies and literature reviews related to online and distance learning get several conclusions. The conclusion is that the trend of online learning topics is more consistently rising and has a higher value than distance learning from 1992-2021. The most commonly used keywords are online learning, and distance metric learning. United States (US) has made the highest contribution over the last thirty years on online and distance learning. The author with the highest citation on online learning is J. C Duchi from the US, the topic distance learning is K.Q. Weinberger from the US. For all these topics, the type of document that is often published in the article. The highest source titles online learning, namely Internet and Higher Education, and distance learning, namely Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition. The highest average citation per paper per year is in 2020 where online learning (n = 170,7) and distance learning (n=118,7). The both topics contribute to learning physics, but distance learning has the lowest citation average, thus, future research related to distance learning in physics will have a lot of potentials, and its novelty will be quite high. The real contributions in physics are to make learning more flexible, train students' independence, train technology, deepen understanding of concepts and make learning more efficient. The advantages of both topics relate to flexibility and types of media that utilize sophisticated digital tools. The disadvantage lies in using the internet network, which requires costs and a strong signal because not all areas have a strong network connection. The limitation of the study is that some research results at Scopus are limited to full access. More intensively, further research can be carried out by comparing other learning systems applied in physics learning.

RECOMMENDATION

The implication of this research is to show the trend of publication of online and distance learning topics so that future researchers can show more benefits related to these topics. With this article, researchers can find out the strengths and weaknesses of each topic and can find updates for future research. The trend results show that online and distance learning topics do not offer a consistent increase every year. However, online learning topics tend to be more consistent and have higher numbers than distance learning. That means that researchers tend to be interested in raising the topic of online learning (Bravou & Drigas, 2019; Rosar & Weidlich, 2022). That is in line with the fact that most education in the world has switched to online learning due to the emergence of the covid-19 pandemic (Alsuraihi, 2022). So it is recommended to conduct future research related to online learning because it has high potential for further research.

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