

A scientometric review of global research on technology in physical education

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ABSTRACT

Since COVID-19, technology-based physical education has been normal and is emerging. This paper is intended to identify the development of scientific publications and map educational technology research pertinent to physical education. The keywords "technology" and "physical education" were searched for in the Scopus and Web of Science databases for this study. The number of papers obtained was 1120. The results of mapping this topic reflected fluctuating trends. Between 2020 and 2021, there was a notable rise in this subject resulting from the breakout of the COVID-19 virus and the subsequent protracted pandemic, which compelled most individuals to rely on technology for learning, including physical education. The source that contributed the most to technology and physical education was the "Journal of Physics: Conference Series." With eight articles, Mikhail Kolokoltsev of the Irkutsk National Research Technical University, Russia, contributed the most to technology and physical education. The most influential and widely cited paper was entitled "Final condition screening system of boys aged 15–17 years in the process of physical education" by Olena et al., 2017. The most frequently used keywords were "physical education," "technology," and "college physical education." With 421 articles, China contributed the most to technology and physical education. This study restricted its search to the years 2017-2021. In light of this, it will be crucial for future studies to create a comprehensive map by examining the first year of publications on this subject. It can be used as a guide to look at more interesting pictures that have not been evaluated or looked at yet.

Keywords: Technology; physical education; scientometrics; scopus; web of science

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INTRODUCTION

Teachers and students engage in an interactive learning process within and outside the classroom. This procedure entails learning and teaching activities that guarantee student success and the achievement of learning objectives (Putria et al., 2020). Learning in schools encompasses various subjects, including

physical education. The topics, especially physical education, are implemented as part of a regular and continuous educational process to enable students to acquire knowledge, develop skills, and have a pleasing personality, virtuous health, and physical fitness (Gil-Arias et al., 2021; Ortega et al., 2022). Physical education is an integral part of the national educational curriculum. Its multi-pronged aims included increasing the potential of students to become human beings who believe and fear God the Almighty, have a noble character, and are healthy, knowledgeable, capable, innovative, and independent (Culajara, 2022; Falkmer et al., 2012). To achieve this goal, educators must be fervently committed to providing quality teaching to ensure a quality learning process. Therefore, physical education should be implemented very well to produce quality output (Richards et al., 2017). To produce quality output, it is thus necessary to efficiently exploit technology in teaching and learning. Appropriate pedagogic strategies aided by the use of technology will impact the quality of teaching and learning, even in physical education, especially when the education sector has been directly implicated by students becoming technology-savvy globally.

The advent of technology in schools has influenced the way educators plan, design instruction, and assess their students. Innovations in educational technology have changed communication systems, learning resources, lesson ideas, and professional development (Cendra et al., 2020). Innovative technology facilitates creativity and learning productivity and, to a large extent, reduces teachers' workload and improves students' motivation and engagement during lessons. Technology can include computer programs, internet programs, other assistive devices, and digital and communicative equipment. Classroom teachers have integrated this form of technology over time using various methods through different styles and practices (Gibbone et al., 2010) to enhance the quality of teaching and learning and to remain relevant in this era of Industrial Revolution 4.0 (IR 4.0).

The current scenario of education in a borderless world makes resorting to applications of learning using technology inevitable. However, this transition poses challenges for learning actors, such as teachers, students, institutions, and even the wider community, such as parents, caretakers, tutors, and guardians. Gawrisch et al., 2020; Krause et al., 2020). Likewise, students must adapt to fast-changing situations and conditions, one of which is psychological readiness (Salsabila et al., 2020). Before deciding how much, when, and why to use technology in their lesson plans, teachers must weigh several factors. Similarly, four reasons form the main concern for physical education teachers when choosing a technology: perceptions of the relevance and importance of technology; teaching styles; technological prowess; and teaching context (Albion & Ertmer, 2002). Then, context would determine which reason or combination of reasons became a priority for the teacher.

There have been many researchers from various countries who have studied educational technology in physical education learning, such as Mexico (Phelps et al., 2021), China (Liu, 2021), (Li & Fan, 2021), Australia (Lupton, 2021), Great Britain (Sargent & Casey, 2021), Rusia (Sosunovsky & Zagrevskaya, 2020), (Egorov et al., 2020), (Kulishenko et al., 2020), Yunani (Tzeni et al., 2020), Belgia (Baymurzin et al., 2019), Spain (González-Campos et al., 2018), South Korea (Lee & Lee, 2021), and Portugal (Jacinto Escola, 2018). These researchers discuss educational technology, human resources, physical education, and health services, systems responsive to learning in universities, and information and communications technology (ICT) applications in learning physical education in colleges and schools.

Relevant literature that discusses the progress of educational technology research in physical education is still extremely limited to date. Some previous research has examined this bibliometric study, namely the trend of publication of technological advantages (Abdullah, 2021b), topics of physical education and sports (Gümüş et al., 2020), and technology in physical education (Calabuig-Moreno et al., 2020; Perdima et al., 2022). However, no research has used scientometric analysis to discuss technology in physical education learning using two databases, namely Scopus and Web of Science (WoS). So, researchers have been compelled to fill in the gaps and explore new perspectives for further research. This paper provides an objective and up-to-date overview of the literature on using educational technology in physical education learning based on scientometric analysis and visualization. It is also aimed at fulfilling the desires and needs of researchers, teacher educators, and practitioners to obtain good, documented data and develop ideas for

future research. Therefore, this study aims to primarily examine the development of scientific publications and map educational technology research in physical education.

METHOD

In accordance with the objectives of this study, a systematic search was carried out in the Scopus and WoS databases, which encompass high-quality scientific research. This bibliographic database contains information on high-quality multidisciplinary research published in scientific journals with significant global impact. It allows for the consolidation of the data set to contribute to this research (Santamaria-Granados et al., 2021), as well as the databases most frequently visited by previous researchers around the world (Abdullah, 2021a; Sweileh, 2020; Yang et al., 2021). To obtain article metadata, a phrase search was carried out in the Scopus and WoS databases on January 16, 2022. This included searching for the titles "technology" and "physical education." A filter to search only papers using English was applied simultaneously, and the type of documents entered only consisted of articles, proceeding papers, and review articles. The number of papers obtained was 1120 (2017–2021), composed of 744 and 376 from the Scopus and WoS databases, respectively. Pre-processing of bibliographic datasets was generated with the ScientoPy tool (Ruiz-Rosero et al., 2019a), and the VOSviewer (Van Eck & Waltman, 2019) was used to generate co-occurrence maps of keywords related to physical education and educational technology. Researchers mapped key contributors (author, university, and source name), applied keyword occurrence analysis to learn publication trends, and tracked the main themes or topics that emerged in the publications.

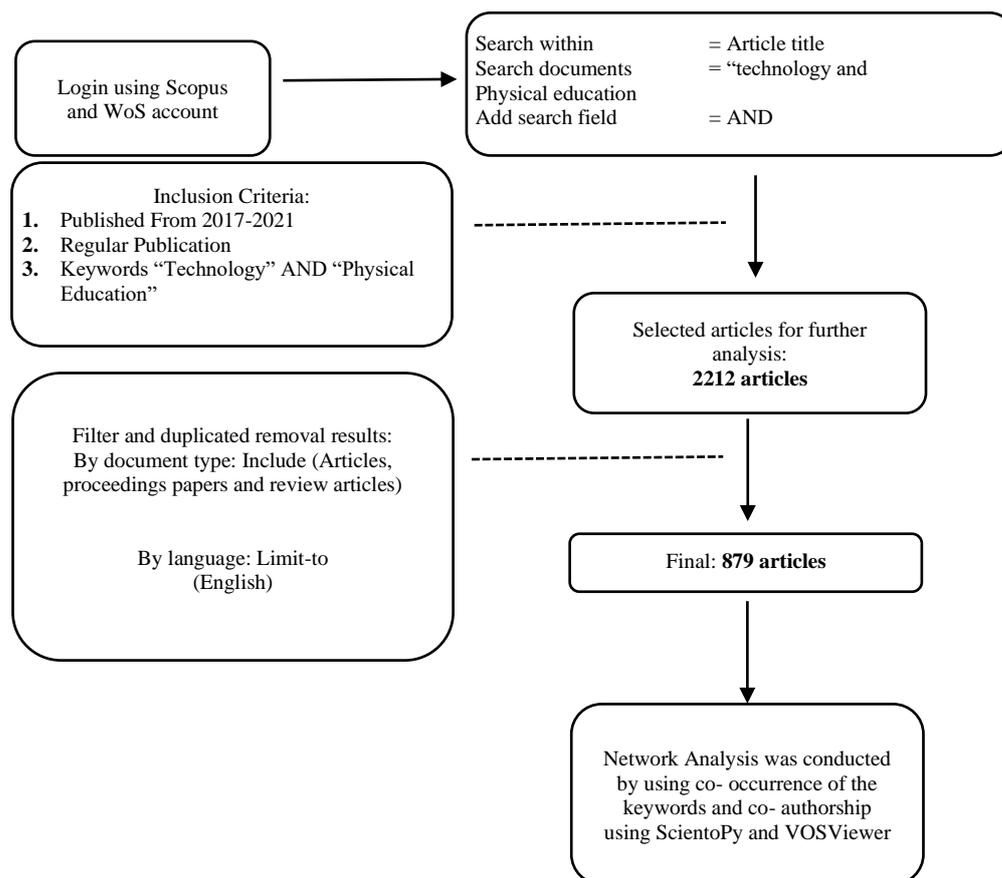


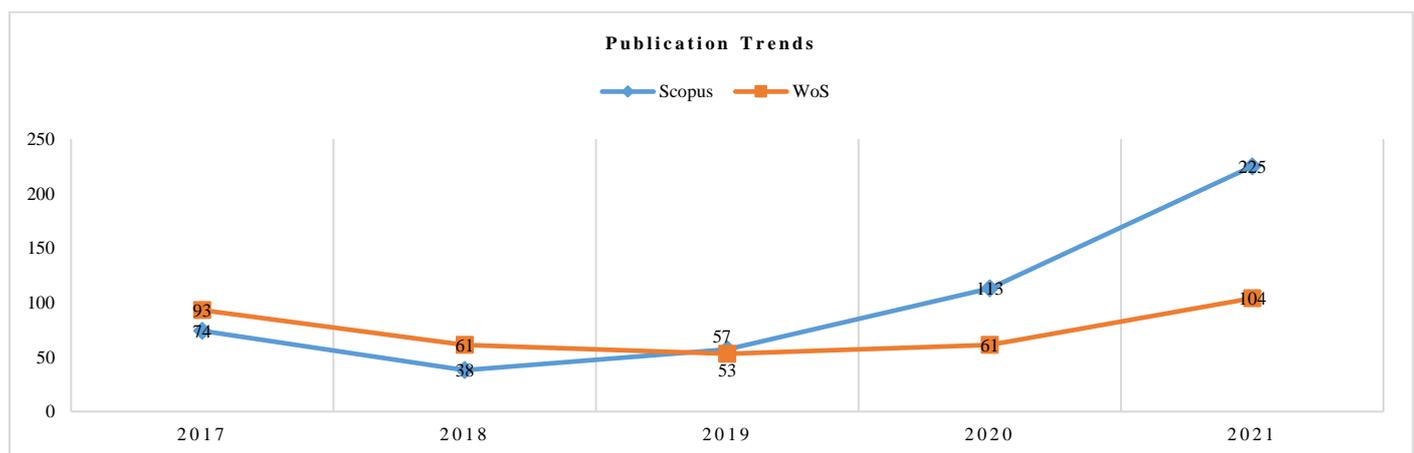
Figure 1. Article Metadata Search Design from Scopus And WoS

RESULTS AND DISCUSSION

This section contains the results of the scientometric analysis according to the research question. First, we presented a literature survey focusing on its evolution over time and contributions in the field by country, organization, and document type. Second, we examined the most influential sources, leading authors, and papers cited in scholarly works. Third, we observed collaboration patterns between authors and countries using co-authorship analysis, existing connections between authors or journals using co-citation analysis, and between terms or keywords using co-word analysis.

A. Trends of Publications

The first papers with the title and keywords "technology" and "physical education" were published in 2017. An analysis based on the two databases (Scopus and WoS) indicated that in 2017 there were 74 articles published in the Scopus database and 93 in the WoS. In 2018, the number of articles published in both databases decreased: Scopus (38) and WoS (61). In contrast, between 2019 and 2021, there was an increase in both databases, namely in 2019, where Scopus soared to 57 articles, but WoS had 53 articles. In 2020, Scopus saw a further increase to 113 articles, and WoS remained at 61 articles. In 2021, Scopus saw a rise to 225 articles, and WoS also almost doubled to 104 articles. Thus, there was a very significant increase in 2020 and 2021. The extension of the COVID-19 pandemic could have contributed to this trend. Many people around the world were using technology to learn at all levels of education, including physical education. (Jumareng et al., 2022; Silva-Filho et al., 2020; Yu & Jee, 2021). The dynamics of the change in publication productivity can be seen in Graph 1.



Graph 1. Scientific Publication Productivity Entitled "Technology" and "Physical Education" from year to year

B. Sources

Table 1 presents the top 10 sources in terms of the number of papers and citations published in technology and physical education. The top three ranked journals were Journal of Physics: Conference Series (87 papers), Journal of Physical Education and Sport (53 papers), and Agro Food Industry Hi-Tech (35 papers) out of the ten identified. Meanwhile, when viewed by the number of citations, the three highest-ranked journals were the Journal of Physical Education and Sport (300 citations), the Journal of Human Sport and Exercise (89 citations), and the International Journal of Emerging Technologies in Learning (88 citations).

Table 1. Top 10 Sources Published and Cited in the Fields of "Technology" and "Physical Education" Indexed on Scopus and the WoS

Rank	Journals	Total	Citation	AGR	ADY	PDLY	h-Index
1	Journal of Physics: Conference Series	87	49	23.5	41.0	94.3	3
2	Journal of Physical Education and Sport	53	300	1.0	12.0	45.3	10
3	Agro Food Industry Hi-Tech	35	28	0.0	0.0	0.0	3
4	ACM International Conference Proceeding Series	30	4	11.5	14.0	93.3	1

Rank	Journals	Total	Citation	AGR	ADY	PDLY	h-Index
5	Boletin Tecnico/Technical Bulletin	30	33	0.0	0.0	0.0	3
6	Boletin Tecnico/Technical Bulletin	30	0	0.0	0.0	0.0	3
7	Journal of Teaching in Physical Education	16	88	3.5	6.5	81.2	6
8	International Journal of Emerging Technologies in Learning	14	58	-3.0	1.5	21.4	5
9	Journal of Human Sport and Exercise	13	89	0.0	3.5	53.8	3
10	Mobile Information Systems	12	8	5.0	5.0	83.3	2

C. Authors

The number of publications and citations by authors were used to identify the most active and influential authors in technology research and physical education. Table 2 and Figure 2 list the top ten authors who have made significant contributions and had an impact based on the number of papers and citations in technology research and physical education. The table includes total publications, average growth rate (AGR), the average number of documents per year (ADY), percentage of documents in recent years (PDLY), and the h-index of authors. Table 2 is presented so that future readers and researchers will recognize the names of known authors in the technology research and physical education fields with whom they may likely collaborate. Mikhail Kolokoltsev from Irkutsk National Research Technical University, Russia, was the most prolific author in technology and physical education with a total of 8 papers. Judging from the analysis for the years 2021 and 2022, eight authors had contributed more than 50% to the papers published, namely Mikhail Kolokoltsev (88%), Elena V Romanova (100%), Anton Vorozheikin (100%), Ming Wang (100%), Li Zhang (100%), Yulu Li (80%), Natal'ya Mischenko (100%), and Xuezheng Zhang (100%). The most influential author was Brendon P. Hyndman from Charles Sturt University, Australia, with 46 citations.

Table 2. Top Ten Authors by Number of Publications and Citations in the Fields of "technology" and "physical education"

Rank	Author	Total	Citation	AGR	ADY	PDLY	h-index
1	Kolokoltsev M.	8	9	2.5	3.5	87.5	2
2	Romanova E.	7	5	2.5	3.5	100.0	1
3	Vorozheikin A.	6	4	2.5	3.0	100.0	1
4	Wang M.	6	5	1.5	3.0	100.0	1
5	Zhang L.	6	1	2.5	3.0	100.0	1
6	Hyndman, B.	5	46	-0.5	0.0	0.0	4
7	Krause, J.M.	5	27	-0.5	1.0	40.0	4
8	Li Y.	5	2	1.5	2.0	80.0	1
9	Mischenko N.	5	3	1.5	2.5	100.0	1
10	Zhang X.	4	1	1.0	2.0	100.0	1

AGR, Average Growth Rate; ADY, Average Documents Per Year, PDLY, Percentage of Documents in Last Years.

D. Paper

In this study, up until January 16, 2022, the author's metadata results produced by ScientoPy showed that the most cited paper written by Olena et al. (2017), entitled "Screening system of the physical condition of boys aged 15–17 years in the process of physical education," published in 2017, had garnered 43 citations. The top 10 most cited papers can be seen in Table 3.

Table 3. Most Cited Papers on Technology and Physical Education

Title	Authors	Journal	Citations	Years
Screening system of the physical condition of boys aged 15-17 years in the process of physical education	Olena Y., Galan Y., Nakonechnyi I., Hakman A., Filak Y., Oleksandra B.	Journal of Physical Education and Sport	43	2017
Modern approaches to improving body constitution of female students within physical education classes	Kashuba V., Kolos M., Rudnytskyi O., Yaremenko V., Shandrygos V., Dudko M.,	Journal of Physical Education and Sport	35	2017

Title	Authors	Journal	Citations	Years
	Andrieva O.			
An Investigation Into the Reasons Physical Education Professionals Use Twitter	Harvey, S., Hyndman, B.	Journal of Teaching In Physical Education	21	2018
Negative effects of smartphone use on physical and technical performance of young footballers	Greco G., Tambolini R., Ambruosi P., Fischetti F.	Journal of Physical Education and Sport	21	2017
Using the methods of mathematical statistics in sports and educational research of masters in physical education and sport	Nataliia B., Lolita D., Oksana S., Kostyantyn S., Vitaly U., Olha S., Syvash I.	Journal of Physical Education and Sport	21	2019
Optimisation of the processes of adaptation to the conditions of study at school as a component of health forming activities of primary school-age children	Kashuba V., Futorny S., Andrieva O., Goncharova N., Carp I., Bondar O., Nosova N.	Journal of Physical Education and Sport	17	2018
Cloud technologies in distance learning of specialists in physical culture and sports	Denysova L., Shynkaruk O., Usychenko V.	Journal of Physical Education and Sport International Journal of Emerging Technologies in Learning	14	2018
A Big Data-Based Data Mining Tool for Physical Education and Technical and Tactical Analysis	Pan, L.	Journal of Teaching in Physical Education	12	2019
Physical Education Teachers' Experiences With Remote Instruction During the Initial Phase of the COVID-19 Pandemic	Mercier, K., Centeio, E., Garn, A., Erwin, H., Marttinen, R., Foley, J.	Journal of Physical Education and Sport	12	2021
Use of health tourism as a basis for improving physical condition of primary school age children	Butenko H., Goncharova N., Saienko V., Tolchieva H.	Journal of Physical Education and Sport	12	2017

E. Author Keywords

Author keywords are keywords chosen by authors to precisely describe the focus of their documents' content. Most authors in the data set examined included their research topic as a keyword in their documents. Author keywords help readers and researchers identify critical ideas and arguments in the respective articles (Abdullah et al., 2022). Countless electronic search engines, databases, and journal sites rely on author keywords to find relevant papers and present them to potential readers. Readers should be aware that keywords generate links to other relevant publications. Scientopy can investigate the evolution of research topics or search arguments based on the keywords used by the authors in this context.

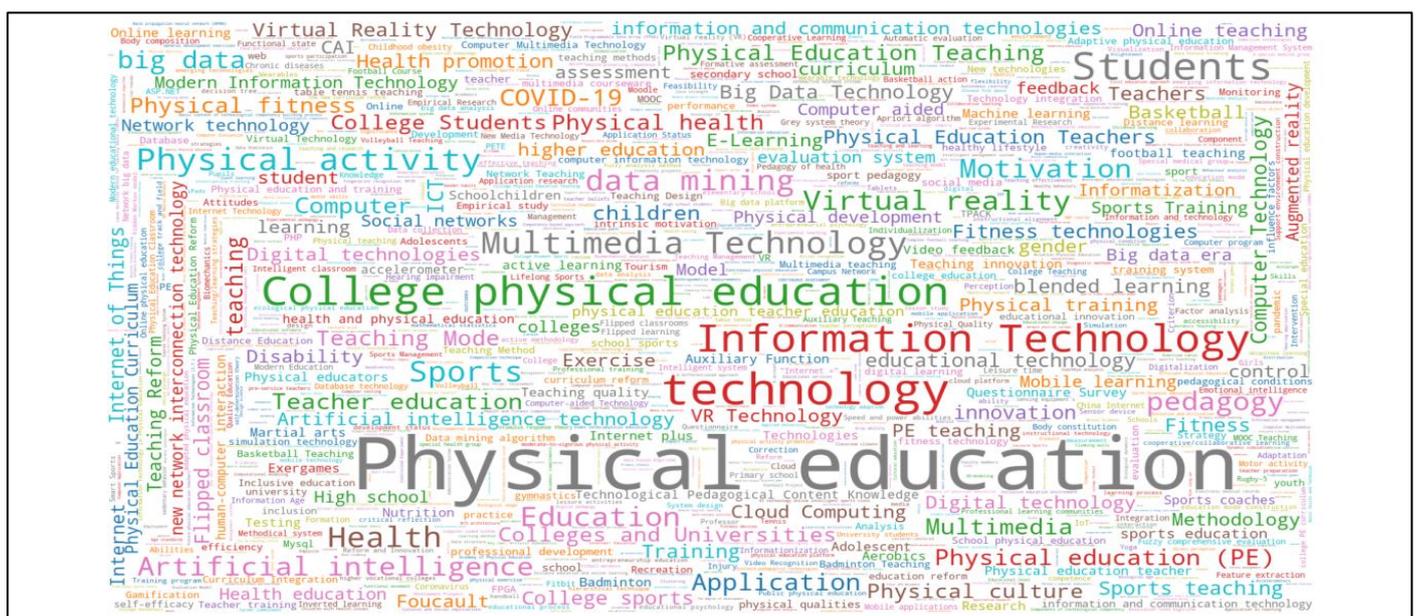


Figure 2. The Authors' Keywords on Technology and Physical Education

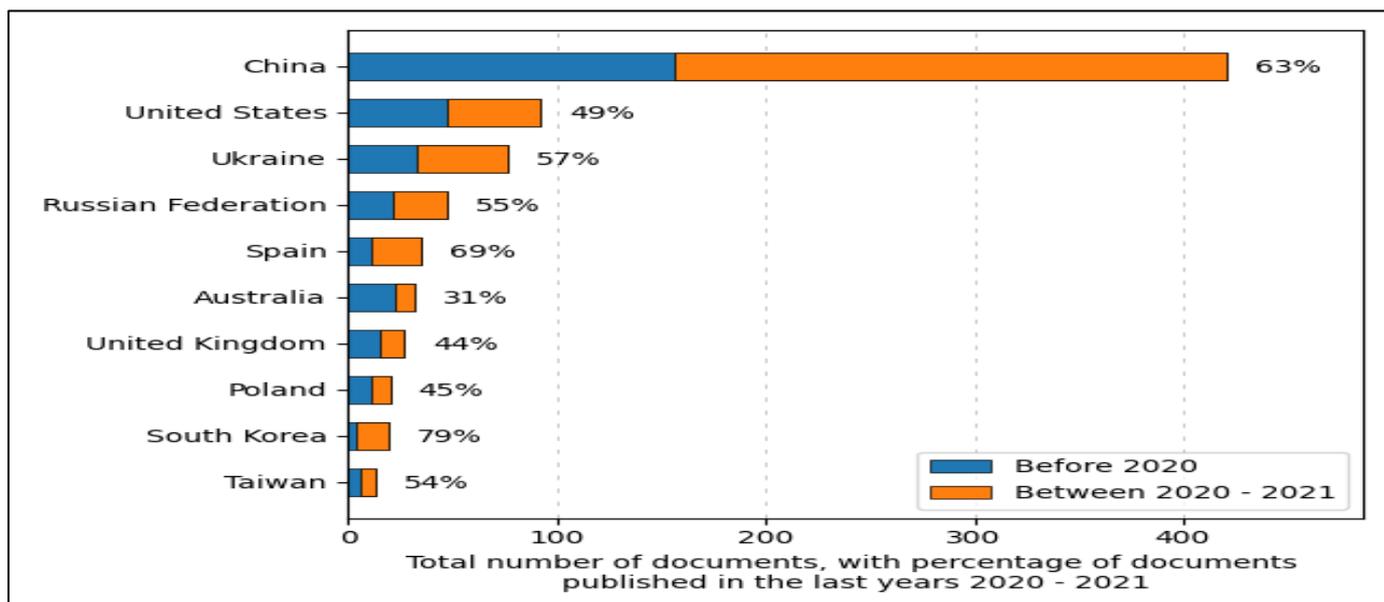


Figure 4. Ten Countries that Published Papers on Technology and Physical Education

In this study, we collected and screened the literature related to the research on technology associated with physical education so as to form a unique literature library. Based on the research topic of technology and physical education, we analyzed the number of papers obtained: 1120 (2017–2021), composed of 744 and 376 from the Scopus and WoS databases, respectively, and gained a solid conclusion from the analysis of visualization. According to the literature review, China has the most papers (421), followed by the United States with 92 papers. According to the analysis above, we make a prediction on the future research direction as follows: The research on technology and physical education was encouraging at the beginning (before 2020), but got less promising between 2020 and 2021. The authors of the above papers mentioned in Table 3 mostly wrote papers that have been cited most often on the importance of technology in physical education.

Today, we understand that physical education needs to be integrated with technology that can assist in teaching and learning physical education. According to Mercier et al. (2021), physical education teachers are not unprepared to use technology during the COVID-19 pandemic. The authors predict that the number will be much higher given the lack of preparedness teachers had in teaching online, combined with the abruptness of the transition to a remote learning environment. The experiences of physical education teachers as they transitioned to remote instruction at the start of COVID-19 provide important insights into the short- and possibly long-term physical education landscape. The link between technology and physical education has also been highlighted by Natalia et al. (2019), where using mathematical dimensions in sports and research in physical education. It is very seldom that authors become interested in mathematics and physical education when information technology comes into the picture. The authors really wanted to show that the experimental methods used in the study were widely used and growing. This study is really into statistics in general.

Something interesting in the area of experimental technology and physical education. There are also studies underway to create a data mining tool for analyzing the technical and tactical aspects of a specific sport. Integrating technology and teaching physical education is very useful when using data mining technology (Pan, 2019). According to some, this source aided physical education teachers in improving students' technical skills in badminton. One of the most important areas of modern research in the field of physical education is the study of the whole spectrum of issues related to health and its formation (Andrieieva et al., 2017). Kashuba et al. (2018) highlighted technology and physical education in a study to develop health-forming technologies in a physical education process. This journal has been cited 17 times, and it shows that the idea of the technology is very crucial, especially for primary-age schoolchildren. An

excellent model was developed in order for the schoolchildren to adapt to the conditions of studying at school. As acknowledged in the article, cloud technology for distance learning of specialists in physical education would also pique interest in understanding the use of technology in physical education. Denysova et al. (2018) emphasized the importance of distance learning in modern higher education. This study did mention that there are the following models of distance education without the use of global networks: Network distance learning: distance learning and mobile cloud distance learning. It seems that cloud-based distance learning is the most promising model for higher education of the athletic type. It is truly one of the most cited journals that highlights technology and physical education.

The use of technology in physical education is widely accepted and has been practiced in many ways. One of the articles by Olena et al. (2017) that introduce a screening system of the physical condition for boys aged 15–17 years in the process of physical education exposes that technology is superb and benefits the teachers by using devices and tools to measure the students' physical ability. It's no surprise that the article has been widely cited and used as a reference. There are many articles related to technology and physical education that are beneficial to physical education teachers and coaches to adapt and use as tools in their teaching and learning environments. According to the articles that highlighted the use of technology in physical education, it can be explained that technology is now essential when engaging students in physical education.

The results of this study depend on literature screened from the Scopus and WoS databases, and the effort is to refine scientific and effective analysis results from the proprietary document library. However, the source of the literature and subjective factors will cause a disparity in the quality and quantity of articles. When elaborating about the current development in education, most countries have already switched to online learning when it comes to educating students. This study clearly explains the need for technology in physical education, and most papers elaborate on the methods and ways to merge the two keywords into reality. We recognize that there are some limitations in this study, as it can only analyze the current situation and trends of research in technology and physical education from a limited perspective, and we will continue to search for, conquer, and improve these shortages in future research, making trend prediction more precise.

CONCLUSION

Using the "Scopus" and "Web of Science (WoS)" databases, this study provides a comprehensive scientometric overview of technology and physical education. The number of papers retrieved was 1120 (2017–2021), consisting of 744 and 376 from the Scopus and WoS databases, respectively. The development of research on this topic between 2017 and 2021 has seen an up and down trend. A significant increase in research on this topic between 2020 and 2021 was conspicuous, possibly due to the worldwide outbreak of the COVID-19 virus and extended lockdowns. That forced everyone to resort to technology for all teaching and learning, including physical education. The source that contributed the most to the technology and physical education fields was the "Journal of Physics: Conference Series" (87 papers). At the same time, the most cited was the "Journal of Physical Education and Sport" (300 citations). Mikhail Kolokoltsev from Irkutsk National Research Technical University, Russia, was the most prolific author in technology and physical education with a total of 8 papers. The most influential writer was Brendon P. Hyndman from Charles Sturt University, Australia, with 46 citations. The most imperative and widely cited paper entitled "Screening System of the Physical Condition of Boys Aged 15–17 Years in the Process of Physical Education" was written by Olena et al. (2017). The most frequently used keywords were "physical education," "technology," and "college physical education." Furthermore, the countries that had contributed the most in the fields of technology and physical education were China (421 papers), and the United States was the most influential country for citations, with a total of 637 citations. However, the limitations of the paper constrain the search years from 2017 to 2021.

For future research purposes, it can be concluded that mapping would be essential by analyzing papers published on this topic from the first year onwards. It can then be used as a reference for looking at other exciting points that have yet to be researched. The exploitation of technology in the field of education,

including the subject of physical education, is here to stay as teachers and students can accrue various benefits from their "marriage." Thus, research in this field will be intensified, and it is hoped that the quality of physical education instruction will continue to improve, along with a diversification of research involving technology in physical education. In the post-COVID-19 pandemic period, it will be fascinating to observe how research and mapping patterns will be affected.

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CONFLICT OF INTEREST

In writing this article, the author affirms that there were no conflicts of interest.

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