

This is an open-access article under the [CC BY-NC-ND](#) license

Issue VII, November 2024

e-ISSN 2707-9481

ISBN 978-601-80473-3-6

Institute of Metallurgy and Ore Beneficiation JSC, Satbayev University, Almaty, Kazakhstan

<https://doi.org/10.31643/2024.11>

#### **Izzul Kiram Suardi**

Yogyakarta State University, Indonesia

Email: [izzul0010pasca.2023@student.uny.ac.id](mailto:izzul0010pasca.2023@student.uny.ac.id)

ORCID ID: <https://orcid.org/0009-0000-1432-0345>

#### **Een Afliani Nur**

Makassar State University, Indonesia

Email: [230024301004@student.unm.ac.id](mailto:230024301004@student.unm.ac.id)

#### **Jumriani Sultan**

Yogyakarta State University, Indonesia

Email: [jumrianisultan.2022@student.uny.ac.id](mailto:jumrianisultan.2022@student.uny.ac.id)

ORCID ID: <https://orcid.org/0009-0008-0690-1535>

#### **Siti Nurjanah**

Yogyakarta State University, Indonesia

Email: [siti960pasca.2023@student.uny.ac.id](mailto:siti960pasca.2023@student.uny.ac.id)

ORCID ID: <https://orcid.org/0009-0006-0727-0830>

## **Mapping Educational Technology Trends in Physical Education: A Bibliometric Analysis Based on The Scopus Database**

**Abstract:** In recent years, digital technologies have played a key role in transforming education, including physical education. This research aims to provide an overview of the application of technology in education, as well as explore its opportunities and challenges in physical education. This study uses secondary data from the Scopus database, consisting of 350 articles published between 1980 and 2024. The selection of articles is based on inclusion criteria that include the keywords "education," "technology," and "physical education" in the title, abstract, or keyword, as well as being included in the social sciences area. The analysis was conducted using the R and VOSviewer applications. The first publication appeared in 1980, with an upward trend starting in 2012 till now. Lviv Polytechnic National University is the most relevant affiliate, while Retos is the journal with the most publications. "Sport, Education, and Society" is the most impactful journal. The most relevant author is Blavt, O., while Goodyear, V.A. is the author with the greatest impact. The keyword "multimedia system" emerged in 2019 and peaked in 2023, along with the keyword "e-learning." The VOSviewer analysis identified three research clusters, and topics such as 'teacher experience' and 'challenges' were found to be still rarely explored, thus offering future research opportunities. The results of this study are useful as a reference for academics and physical education practitioners who want to research the topic of educational technology.

**Keywords:** Bibliometrics, educational technology, physical education.

### **Introduction**

In recent years, digital technology has played a key role in transforming education. Technologies such as artificial intelligence (AI) and data-driven tools allow for more effective personalization of learning. Teachers can tailor teaching to the individual needs of students, significantly improving learning outcomes (Hartman et al., 2019). The development of 5G networks accelerates the implementation of technologies in learning, such as the Internet of Things (IoT), artificial intelligence, and Augmented Reality (AR)/Virtual Reality (VR). The technology allows for a more interactive and immersive learning environment, facilitating distance learning, global collaboration, and access to a wider range of resources. This shows that education is now becoming more flexible and accessible to more students (Ammanamanchi & Domede, 2024).

Technology has had a significant impact on teaching methods, allowing teachers to create a more interactive and adaptive learning environment. The application of technology helps create a more focused learning approach to student needs, provides greater flexibility in learning methods and times, and facilitates collaboration between students and teachers in various locations. Tomar & Soni (2024) stated that the integration of technology into learning makes teaching materials more interesting. The use of multimedia and interactive tools can increase students' motivation to learn so that they are more involved in the learning process. Rabani et al., (2023) stated that technology improves students' digital skills, accelerates the learning process, and increases the efficiency of teachers' and lecturers' administrative tasks. The benefits of technological collaboration in education are felt in various aspects, such as increased access to educational resources, the effectiveness of teaching methods, and the improvement of student learning outcomes.

Technology helps overcome the limitations that exist in the traditional education system, such as time, space, and resource limitations.

Educational technology in physical education has undergone significant development in recent years, and one of the important approaches to understanding it is through bibliometric analysis. This analysis is especially important to identify challenges and opportunities in the use of technology in physical education because it can present information about the pattern of literature development effectively and efficiently. With bibliometric analysis, researchers can understand the structure, dynamics, and impact of educational technology on physical education (Oluwadele et al., 2023). Bibliometrics also allows for the measurement of scientific work mathematically and statistically (Diodato & Gellatly, 2013), helping to explore research development trends in physical education, especially those related to technology (Bornmann & Leydesdorff, 2014).

Compared to experience-based or experiment-based methods, bibliometric analysis has the advantage of collecting and processing copious amounts of technical information. The results of this method are more objective and allow for an in-depth dig into the relevant scientific literature to uncover patterns of technological change in physical education (Huang et al., 2020). According to (Julia et al., 2020), the bibliometric analysis examines seven key areas, including publication trends, leading journals, most cited articles, common keywords, author collaboration networks, institutional collaboration patterns, and overall statistical trends.

The bibliometric approach is invaluable in mapping research on the use of technologies such as augmented reality (AR) or interactive learning applications in physical education. (Mejia et al., 2021). Through this approach, decision-making regarding research priorities can be more directed, and trends in physical education science and technology can be observed more accurately. Bibliometric analysis is not a substitute for experimental methods but is a complementary approach that can provide a macro picture related to publication patterns (Ellegaard & Wallin, 2015; Öztürk et al., 2024), while the experimental method offers deeper micro-insights regarding the direct influence of technology on physical learning. Thus, educational technology in physical education can be optimized through a thorough understanding of research trends and the application of these technologies, which are identified through bibliometric analysis.

Through this study, an analysis of technology research trends in education and sports education was conducted using a bibliometric approach from the Scopus Database. The purpose of this study is to provide an overview of how technology has been applied in education, as well as to explore the opportunities and challenges that exist in sports education. Thus, it is hoped that the results of this study can provide a better understanding of integrating technology in sports education.

**Research question:**

How are the trends of technology research in education and sports education developing based on bibliometric analysis from the Scopus Database, and what are the opportunities and challenges that arise in the application of technology in sports education?

**Research procedure**

This study uses the Scopus database as a source of data related to the use of educational technology in sports education. Scopus was chosen because it can update the database more effectively and efficiently so that it can assist researchers in analyzing citations, calculating research collaborations, reporting annual productivity, and exporting data into CSV and RIS formats for more in-depth tabulation and mapping purposes (Oluwadele et al., 2023). There were 350 articles found using the criteria that had been determined (see Table 1).

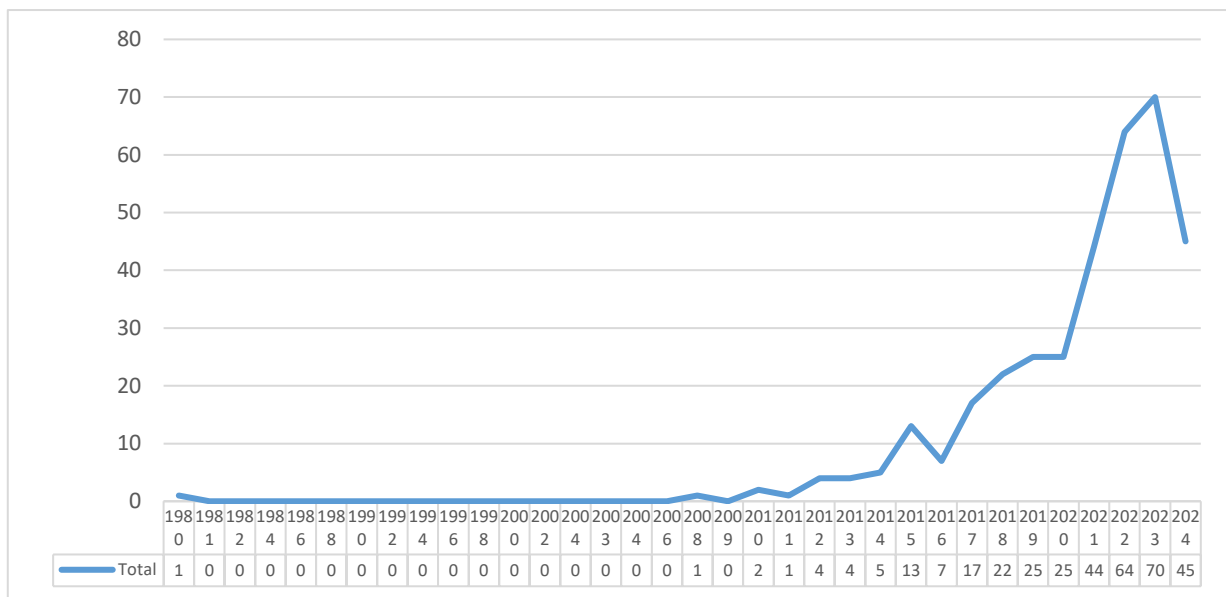
The data obtained through Scopus is then analyzed using VOSviewer and R Studio by utilizing the 'biblioshiny' package which can subsequently provide visualization and analysis of indicators related to research trends, such as publication productivity, active authors, and developing research trends. (Ibrahim et al., 2023; López Belmonte et al., 2020; Nurjanah et al., 2024). The data that has been obtained from the Scopus database and has met the requirements, is then exported as a . RIS and . CSV. Next, the data is processed through RStudio using the biblioshiny package (Nurjanah et al., 2024) and also processed via VOSviewer.

**Table 1:** Criteria of article inclusion

Search within	Search documents
Article title, abstract, keywords	"education" AND "technology" AND "physical education"
Document Type	Article
Subject area	Social sciences
Years	1980 – August 2024

**Research results and discussions**

**Publication productivity related to the use of technology in physical education based on the Scopus Database.** Based on the results of the search and selection conducted on data obtained through the Scopus database, it was found that the first research related to this topic has emerged since 1980. However, no research was found on related topics until 2007. In 2008, this topic began to be researched again and in 2012 it became the starting point for topics related to educational technology in sports education to begin to develop. Figure 2 shows the developments related to publications on this topic.



**Figure 1.** Number of publications in each year

The first research on this topic comes from research conducted by Allison & Ayllon in 1980. In contrast to the current definition of technology which usually focuses on technology physically, the Allison & Ayllon research (1980) The technology in question is a behavioural technology that adheres to behavioral principles to teach motor skills in sports. In his research, he uses behavioral technology in physical education to reduce errors and strengthen motor skills effectively. The method used in his research succeeded in improving the performance of athletes in skills such as blocking in football, walkover in gymnastics, and forehand hitting in tennis up to many times compared to coaching methods.

Unfortunately, after 1980, no research on educational technology in physical education was found for 28 years. The lack of research on this topic can be caused by the substantial number of educators who tend to stick to traditional methods, as well as the physical education identity crisis that makes their roles and goals less clear. (Ardiyanto, 2018). New research began to resurface in 2008, and there was an incredibly significant increase between 2020 and 2020, with a rise of 156% during that period. This is believed to be due to the Covid-19 Pandemic which forced all learning to use online methods (Gopika & Rekha, 2023; Winter et al., 2021). The development of articles in the last five years, namely 2020 (25 articles), 2021 (44 articles), 2022 (64 articles), 2023 (70 articles), and 2024 (45 articles). Based on these data, we can see that research on this topic has developed significantly, and of course, this shows considerable potential for further study.

In the affiliate category, three universities are affiliated with the highest level of publications. The three universities are Lviv Polytechnic National University from Ukraine, Universidad Rey Juan Carlos from Spain, and the University of Limerick from Ireland. In detail, in Table 2 we have summarized a list of the 10 affiliates with the highest number of publications.

**Table 2. Affiliates with the most publications**

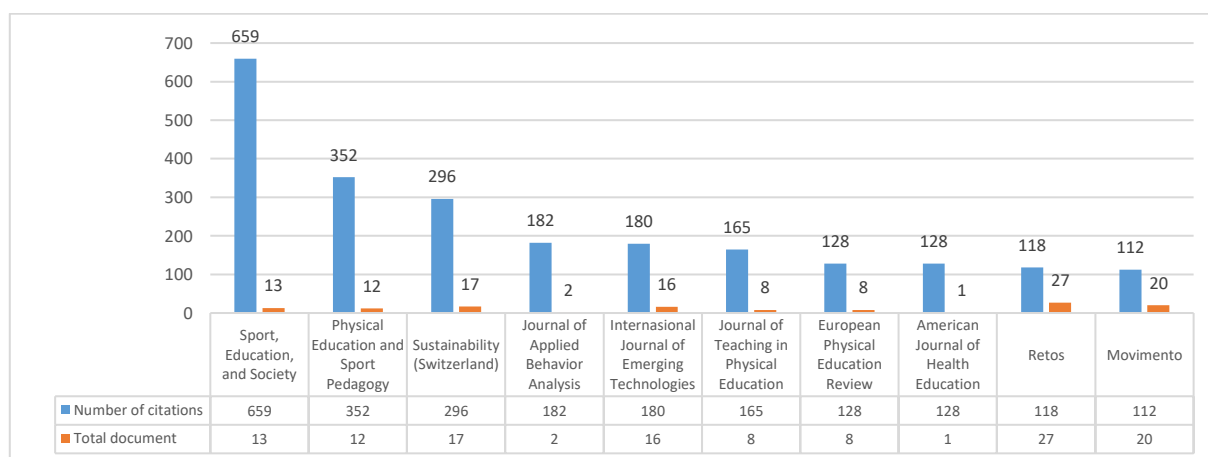
Category	Top 10 Publications
Affiliations	Lviv Polytechnic National University (19), Universidad Rey Juan Carlos (16), University of Limerick (14), University of Alicante (13), Spiru Haret University (10), University of Wollongong (9), Federal University of Rio Grande Do Norte (8), Kamianets-podilskiy Ivan Ohiienko National University (8), Dublin City University (7), Universidad De Granada (7).

**The most popular publications, authors, and articles related to the use of technology in physical education.** In topics related to educational technology in the field of physical education, the analysis conducted using the Scopus database identified as many as 350 articles published in 130 different journals. These journals certainly have a diverse impact, which is measured by the number of citations from each journal, author, and article published (Nurjanah et al., 2024). Table 3 presents a list of the 10 journals with the highest number of articles on this topic. The top three journals include "Retos" from Spain with 27 articles (7.71%), "Movimento" from Brazil with 20 articles (5.71%), and "Sustainability" from Switzerland with 17 articles (4.86%).

**Table 3. Top 10 Journals related to collaboration between educational technology and physical education**

Journal	Number of documents	Percentage
Retos	27	7,71%
Movimento	20	5,71%
Sustainability (Switzerland)	17	4,86%
International Journal of Emerging Technologies in Learning	16	4,57%
Sport, Education, and Society	13	3,71%
International Journal of Human Movement and Sports Sciences	12	3,43%
Physical Education and Sport Pedagogy	12	3,43%
Rehabilitation and Recreation	10	2,86%
European Physical Education Review	8	2,29%
Journal of Teaching in Physical Education	8	2,29%

Retos, which is a journal whose focus is on physical education, has made a significant contribution to topics related to educational technology in physical education. The journal has played an important role in disseminating the methods, functions, and effectiveness of the use of educational technology in physical education. In addition, the journal also encourages international collaboration among researchers, creating a global community dedicated to advancing technological collaboration in the world of education. In addition, this collaboration also promotes the development of educational technology in the world of physical education. So, this journal can be one of the goals for researchers who have an interest in this topic. In line with what said that choosing the right journal can not only help the development of science but also help promote the academics of an academic (Shamsi et al., 2023).



**Figure 2. Top 10 most cited journals**

In terms of impact based on the number of citations, it has been shown in Figure 2 a list of the 10 journals with the highest citations on this topic. The three journals with the highest citations were "Sport, Education, and Society" from the United Kingdom with 659 citations, "Physical Education and Sport Pedagogy" from the United Kingdom with 352 citations, and "Sustainability" from Switzerland with 296 citations.

Furthermore, the author is the most active and influential on the topic of educational technology in physical education. In this section, the analysis is conducted based on the number of publications and the number of citations obtained. Of the 350 articles obtained and analyzed, 1010 authors are actively involved in this topic. In the most productive category (see Table 4), the three authors with the highest number of publications are Blavt, O. from Ukraine with eight articles, Casey, A. from the United Kingdom with seven articles, and De Araújo, A. C. from Brazil and Goodyear, V. A. from the United Kingdom, who each have six articles on this topic. Then in the most cited category (see Table 5), the three highest authors in the category are all from the United Kingdom, namely Goodyear, V. A. with 707 citations, Casey, A. with 437 citations, and Kerner, C. with 275 citations.

**Table 4.** Top 10 most productive authors

Authors	Country	Document
Blavt, O.	Ukraine	8
Casey, A.	United Kingdom	7
De Araújo, A. C.	Brazil	6
Goodyear, V. A.	United Kingdom	6
Sargent, J.	United Kingdom	5
Østerlie, O.	Norway	5
Calderón, A.	Ireland	4
Gil-Espinosa, F. J.	Spain	4
Scanlon, D.	Australia	4
Burgueño, R.	Spain	3

**Table 5.** Top 10 most influential authors

Authors	Country	Quotation
Goodyear, V. A.	United Kingdom	707
Casey, A.	United Kingdom	437
Kerner, C.	United Kingdom	275
Kirk, D.	United Kingdom	204
Quennerstedt, M.	Sweden	154
Armour, K. M.	United Kingdom	133
Williamson, B.	United Kingdom	130
Marttinen, R.	United States	120
Rye, E.	United States	112
Erwin, H.	United States	112

Oksana Z. Blavt is an author with a significant contribution to the topic of educational technology in physical education through her productive research results. As one of the researchers from Lviv Polytechnic National University, his focus on the application of technology to learning in physical education highlights his dedication to exploring effective teaching methods that improve students' understanding of the concepts that exist in sports. His work, of course, has broadened the horizons for the implementation of educational technology in physical education. In addition, Dr. Victoria Goodyear, PhD., SFHEA., a researcher from the University of Birmingham who focuses on research related to pedagogies in sport, also made a great contribution to this topic. This can be seen in the number of citations he got, which is 707 citations on this topic. One of his research projects that is quite popular on this topic is research related to the use of healthy lifestyle technology that can be worn by young people. His research gives the idea that although daily goals such as 10,000 steps and calorie burn set by the Fitbit device encourage higher physical activity at first, their effectiveness decreases over time.

Based on 350 articles obtained through the Scopus database, we have identified the 10 articles with the greatest influence on the topic of educational technology in physical education (see Table 6). Article with the title "Young people's uses of wearable healthy lifestyle technologies; surveillance, self-surveillance and resistance" by Goodyear et al. (Goodyear et al., 2019) Became the most influential article on this topic with 147 citations. Then, the second position is supported by an article titled "Rethinking the Relationship between Pedagogy, technology and Learning in Health and Physical Education" by Casey et al. (Casey et al., 2017). In third place, an article titled "Algorithmic Skin: health-tracking Technologies, Personal Analytics and the Biopedagogies of Digitized Health and Physical Education" by Williamson (Williamson, 2015). These three articles come from the same journal, namely the Sport, Education and Society journal managed by Routledge, United Kingdom.

The top ten most cited articles mainly discuss how the use of technology in physical education can increase engagement and physical activity in learners. These articles are widely cited because they can provide a strong empirical picture and evidence that shows how the application of technology when integrated into physical education is compared to traditional teaching approaches in physical education.

**Table 6.** Top 10 most influential articles (number of citations)

Title	Reference	Journal	Citation
Young people's uses of wearable healthy lifestyle technologies; surveillance, self-surveillance, and resistance	(Goodyear et al., 2019)	Sport, Education, and Society	147
Rethinking the relationship between pedagogy, technology and learning in health and physical education	(Casey et al., 2017)	Sport, Education, and Society	133
Algorithmic skin: health-tracking technologies, personal analytics and the pedagogies of digitized health and physical education	(Williamson, 2015)	Sport, Education, and Society	130
The Motivational Impact of Wearable Healthy Lifestyle Technologies: A Self-determination Perspective on Fitbits With Adolescents	(Kerner & Goodyear, 2017)	American Journal of Health Education	128
Tweet me, message me, like me: using social media to facilitate pedagogical change within an emerging community of practice.	(Goodyear et al., 2014b)	Sport, Education, and Society	120
The effects of exergaming on physical activity among inactive children in a physical education classroom	(Fogel et al., 2010)	Journal of Applied Behavior Analysis	109
Barriers and facilitators to using digital technologies in the Cooperative Learning model in physical education	(Bodsworth & Goodyear, 2017)	Physical Education and Sport Pedagogy	95
Exploring the changes in physical education in the age of Covid-19	(Varea et al., 2022)	Physical Education and Sport Pedagogy	86
Hiding behind the camera: social learning within the Cooperative Learning Model to engage girls in physical education	(Goodyear et al., 2014a)	Sport, Education, and Society	84
How can video feedback be used in physical education to support novice learning in gymnastics? Effects on motor learning, self-assessment, and motivation	(Potdevin et al., 2018)	Physical Education and Sport Pedagogy	79

**The most popular keywords and trends in research related to the use of technology in physical education are in the Scopus database.** In this section, we have identified the research areas that are the

main focus of research related to educational technology in physical education. Through this analysis, the development of this topic can be observed. By utilizing the keyword plus setting from the 350 articles collected as many as 50 keywords were generated. The keywords are then analyzed to assess the frequency of their use and identify keyword trends over time. Figure 3 shows the frequency of use of this topic word. The five most widely used keywords were physical education (31), teaching (21), human (16), education (15), student (15), and learning (14).



Figure 3. Trending words that appear most often

The finding of the most frequently emerged keywords from the 350 articles analyzed described the development of research related to the topic of educational technology in physical education. Keywords such as teaching, education, student, and learning reflect the application of technology to student-centered physical education, which is in line with the theory of constructivist learning. The application of educational technology to physical education has improved the quality of learning (AL-Sinani & Al Taher, 2023; Lai, 2024; Lobo et al., 2024; Narciso, 2023; Qian, 2024), increase student engagement and participation (Asogwa et al., 2020; Gil-Espinosa et al., 2023; Lai, 2024; Luo, 2023; Moreno-Guerrero et al., 2021), and motivation and fun learning (Moreno-Guerrero et al., 2021; Ponce et al., 2022; Quintas-Hijós et al., 2020).

Furthermore, the trend of word use over time on the topic of educational technology in physical education (see Figure 4). From the results of the analysis, the topic trend began in 2016 and the first topic that emerged was "sport". However, it started to become a trend in 2018 along with "physical education". After that, the trend of "physical education" has been consistently used with 31 frequencies. For 2024, the keyword "motivation" (since 2020) and the keyword "college physical education" (since 2019) are the most commonly used keywords with a total frequency of five for these two keywords.

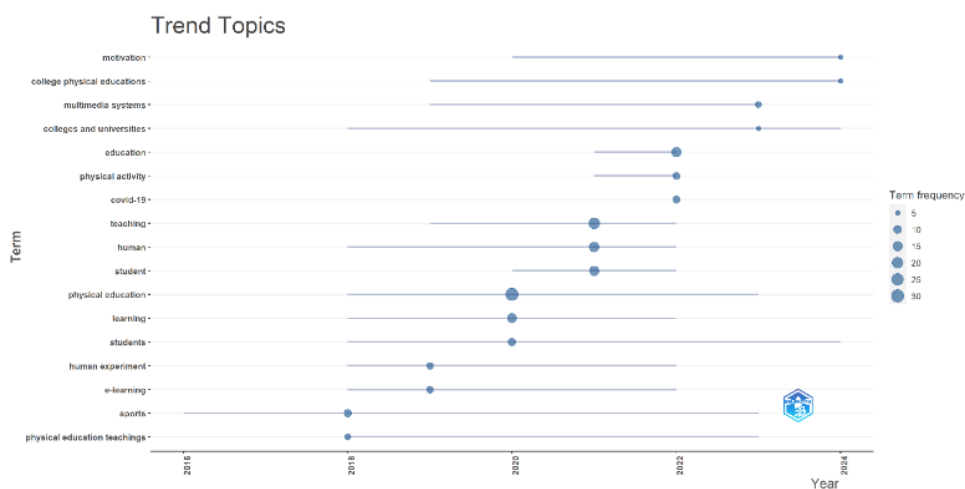
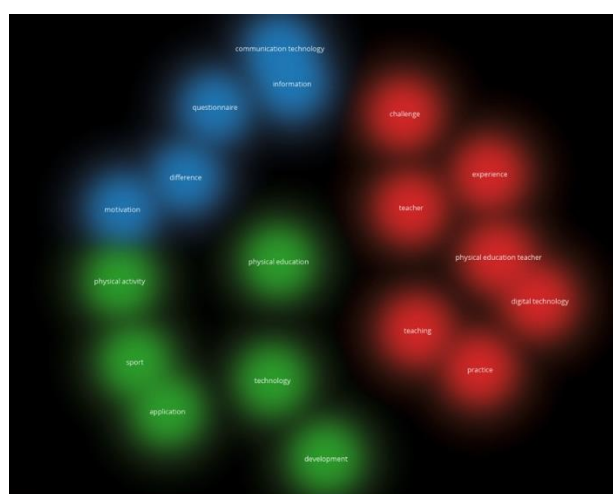


Figure 4. Trends in word usage over time

The keyword trend section in the article discusses the topic of educational technology in physical education has consistently started to develop since 2016. In the development of the keyword trend, the keyword sports is the keyword that appears for the first time on this topic. This shows that the roots of this

topic start from the application of educational technology to sports. Furthermore, in 2019, multimedia system keywords began to appear alongside e-learning keywords and peaked in 2023 as seen in Figure 4.

**VOSViewer analysis result.** The relationship between keywords can be seen from the grouping or grouping of several keywords related to physical education. Figure 5 shows a concept map or visualization of the linkage of keywords related to education, sports, technology, and challenges in the context of physical education learning and the application of digital technology, which are grouped into three clusters or groups. The blue color group includes keywords such as communication technology, information, questionnaires, online, and motivation. This cluster shows the relationship between communication technology, information collection through online questionnaires, and student motivation. This shows that communication technology plays an important role in supporting physical education learning through online methods, including collecting data on student participation or motivation more efficiently (Lumbantobing et al., 2024). This technology can also help teachers better understand the needs of their students and provide a more personalized learning experience.



**Figure 5.** Density visualization (cluster density)

The green cluster focuses on words like sports, physical activity, education, technology, apps, and development. It shows the link between physical education, sports, and the application of technology. The green color describes how technology can be integrated into physical activities and sports, which involves the application of technology in the form of applications or digital devices to support the development of students' skills. It can also involve the use of sports-specific apps or technological tools that aid in the measurement of students' performance and physical activity.

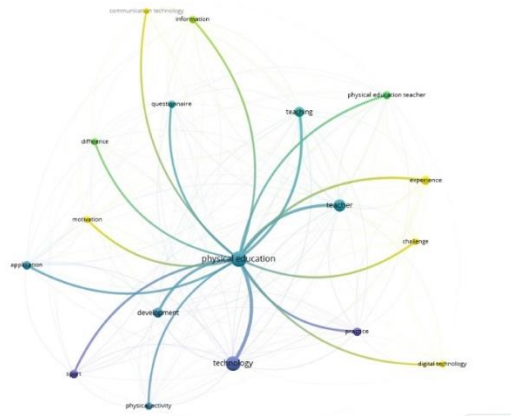
The red color group consists of words such as challenge, experience, teacher, physical education teacher, digital technology, teaching, and practice. This color represents the challenges faced by physical education teachers in implementing digital technology into teaching. These challenges may be related to a lack of experience or training in the use of technology, adaptation to digital change, and how teachers must adapt their teaching practices to incorporate digital tools. The group highlighted the need to overcome these barriers for technology to truly improve the physical education teaching process.

The three-color clusters show the close relationship between technology and physical education and the challenges faced in integrating technology into such learning. These colors help group keywords based on thematic areas that are interconnected between technology and communication (blue), physical education and sports (green), and teaching challenges and teacher experience (red).

**Visualization analysis of topics related and contribution.** Based on Figure 6, the visualization analysis of topics related to physical education shows that concepts such as 'technology', 'development', 'experience', 'physical education teacher', and 'student' are related to physical education. The lines connecting these elements illustrate the close relationship between technology, development, experience, and the role of teachers in supporting physical education learning. The different colors in these visualizations can be used to group specific categories or themes, such as technology, pedagogy, or physical activity. For example, the terms 'digital technology' and 'application' are connected to 'technology', which indicates the importance of the application of technology in the teaching of physical education. In addition, these aspects are interrelated

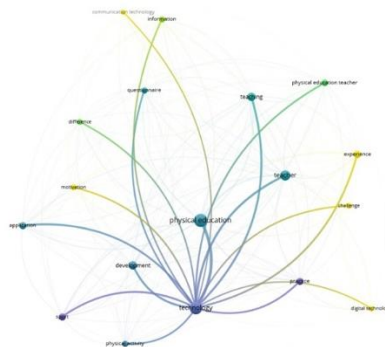


in advancing physical education through a modern and interdisciplinary approach. For example, the use of fitness apps or wearables (e.g., smart watches) in physical education classes to track students' physical activity (Filiz et al., 2024). This technology allows for more scalable and interactive teaching.



**Figure 6.** Topics related to physical education

Based on Figure 6, the visualization analysis of topics related to physical education shows that concepts such as 'technology', 'development', 'experience', 'physical education teacher', and 'student' are related to physical education. The lines connecting these elements illustrate the close relationship between technology, development, experience, and the role of teachers in supporting physical education learning. The different colors in these visualizations can be used to group specific categories or themes, such as technology, pedagogy, or physical activity. For example, the terms 'digital technology' and 'application' are connected to 'technology', which indicates the importance of the application of technology in the teaching of physical education. In addition, these aspects are interrelated in advancing physical education through a modern and interdisciplinary approach. For example, the use of fitness apps or wearables (e.g., smart watches) in physical education classes to track students' physical activity (Filiz et al., 2024). This technology allows for more scalable and interactive teaching.

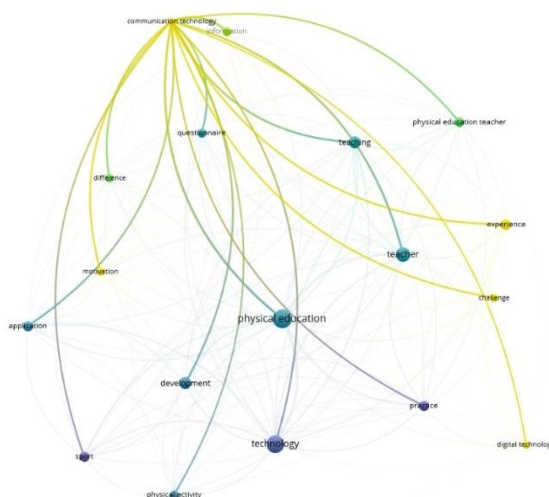


**Figure 7.** Topics related to technology

Furthermore, the analysis of Figure 7 shows the complex relationships between various concepts in the context of physical education, involving aspects of technology, teaching, development, and student experience. This relationship confirms that physical education not only includes physical activity but is also closely related to the application of modern technology and pedagogical approaches. For example, the link between physical education and technology suggests that technology can be applied to improve the learning experience, such as the use of wearables and fitness apps to monitor students' physical activity. In addition, the relationship between physical education and development highlights the importance of curriculum development programs that focus on improving students' motor skills through innovative and technology-based learning methods (Bangun et al., 2023).

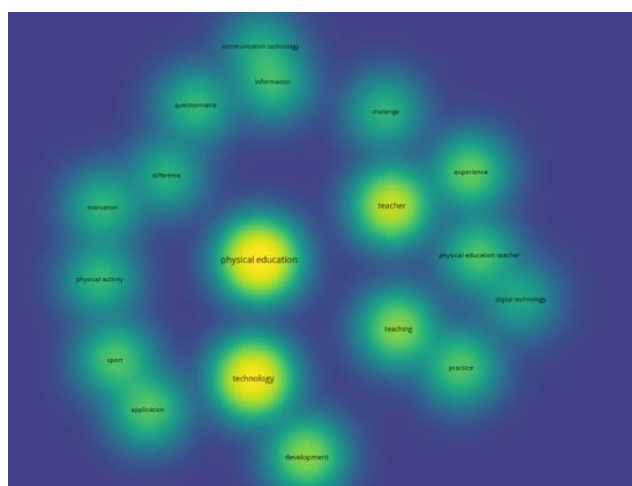
In addition, the relationship with physical education teachers suggests that the role of teachers is crucial in facilitating the student learning experience, where technology such as interactive boards or video tutorials can help teachers explain exercise techniques more effectively (Ospankulov et al., 2023). It also

supports the relationship between experience and teaching, where the student learning experience can be enhanced through teaching methods that focus on interactive and collaborative physical activity, such as team sports games that enhance social skills (Johnson, 2018). In addition, the importance of digital technology in physical education reinforces the idea that the integration of digital technology helps students to be more engaged and motivated in physical activities (Bogdanovskaya & Andreichenko, 2024). In addition, examples of the application of technology in sports learning are technological tools such as smartwatches and sensors used to measure athletes' performance, monitor physical activity, and improve training methods in sports, as discussed in the research paper (Cristina NAE, 2024).



**Figure 8.** Topics related to communication technology

Figure 8 shows how technology is increasingly playing an important role in improving the quality of physical education learning. For example, the relationship between physical education and communication technology shows the role of communication technology in facilitating the interaction and distribution of information in physical education classes, such as using online learning applications or student-teacher communication platforms (Vampugani et al., 2020). In addition, the relationship between the keywords experience and teachers emphasizes the important role of teachers in creating meaningful learning experiences for students. Teachers can use digital technology to enrich teaching with demonstration videos or interactive sports apps that increase student engagement (Bores-García et al., 2024).



**Figure 10.** Destiny visualization (item density)

Other relationships such as between physical education and development keywords highlight the importance of development programs that integrate technology to improve students' physical skills, such as app-based exercise programs that track students' fitness progress individually (Brown & Zhang, 2024). Meanwhile, the link between motivation and students shows that the right use of technology can increase students' motivation to participate in physical activities in the classroom (Johnson, 2018). Therefore, the

integration of digital technology in physical education is an important strategy to increase the effectiveness of teaching, both in physical and cognitive aspects.

**Future research opportunities.** Based on Figure 10, explains future research opportunities, especially those related to the integration of digital technology in physical education. From the visualization of the density of the images, the keywords that appear in lighter colors, such as 'physical education' and 'digital technology', indicate a topic that has been extensively researched. In contrast, darker-colored keywords, such as 'teacher experience' and 'challenge', indicate topics that are still rarely explored. This could be an opportunity for future research, especially on how physical education teachers face the challenge of integrating digital technology into their teaching practices. Research in this area can provide new insights into practical challenges and possible solutions.

## Conclusions

Publications related to educational technology in physical education began to appear in 1980 but only developed significantly after 2012. The surge in the number of research developments occurred in the 2020-2024 range, indicated by the Covid-19 pandemic which accelerated the adoption of technology in learning. Retos is the most relevant journal with the most sources of article documents, while "Sport, Education, and Society" is the most impactful journal with the most citations. Authors such as Oksana Blavt and Victoria Goodyear became the most active and influential contributors. In addition, the keywords that are often used in this study, such as "physical education", "teaching", and "learning", reflect a trend that focuses on the integration of technology in physical activity and student-based learning. The results of the VOSViewer analysis identified three main clusters that show the relationship between technology, physical education, and pedagogical challenges. This cluster describes how communication technology, sports applications, and digital devices can support learning, although implementation challenges for teachers are still an obstacle. The visualization further highlights the importance of digital technologies such as fitness apps and implementable devices to enhance student engagement and support more interactive teaching methods. This research also opens up opportunities for future research exploration, especially in overcoming the challenges faced by teachers in integrating digital technology into physical education teaching practices.

**Research recommendation.** This research has limitations because it only uses data from the Scopus database, so further research can expand its scope by using other databases such as Web of Science or Google Scholar. The main benefit of this research is to provide an evaluation of technological research trends in physical education, as well as provide a valuable reference for future researchers to determine the direction of research, select a target journal, and find opportunities for collaboration with relevant authors or institutions on this topic.

**Credit author statement:** I.K. Suardi: Conceptualization, Methodology, Software, Validation, Writing draft preparation. J. Sultan: Supervision, Data curation, Software. E.A. Nur: Conceptualization. S. Nurjanah: Reviewing and Editing.

**Acknowledgment.** The authors would like to thank anonymous reviewers and the conference editors for their comments on earlier versions to improve this study's quality.

**Cite this article:** Suardi, I.K., Sultan, J., Nur, E.A., Nurjanah, S. (2024). Mapping Educational Technology Trends in Physical Education: A Bibliometric Analysis Based on The Scopus Database. *Challenges of Science*. Issue VII, pp. 76-88. <https://doi.org/10.31643/2024.11>

## References

- Allison, M. G., & Ayllon, T. (1980). Behavioral Coaching in The Development of Skills in Football, Gymnastics, and Tennis. *Journal of Applied Behavior Analysis*, 13(2), 297–314. <https://doi.org/10.1901/jaba.1980.13-297>
- AL-Sinani, Y., & Al Taher, M. (2023). Enhancing teaching skills of physical education teachers in the Sultanate of Oman through augmented reality strategies: A comprehensive feedback-based analysis. *Cogent Social Sciences*, 9(2). <https://doi.org/10.1080/23311886.2023.2266253>

- Ammanamanchi, S. L., & Domede, A. B. (2024). *Technology Growth-Based Transformation in Education: Understanding the Role of Technology and Teachers* (pp. 155–166). [https://doi.org/10.1007/978-3-031-63402-4\\_13](https://doi.org/10.1007/978-3-031-63402-4_13)
- Ardiyanto, H. (2018). Integrasi Teknologi dalam Pendidikan Jasmani: Peluang untuk Menjawab Krisis Identitas dan Legitimasi? In R. Hayati, L. P. Sari, & A. Latifah (Eds.), *Seminar Nasional KMP UNY 2018: Implementasi Riset dan Literasi untuk Meningkatkan Keterampilan Abad XXI* (pp. 105–114). UNY Press.
- Asogwa, U. D., Ofoegbu, T. O., Eseadi, C., Ogbonna, C. S., Eskay, M., Nji, G. C., Ngwoke, O. R., Nwosumba, V. C., Onah, B. I., & Das, U. N. (2020). The effect of a video-guided educational technology intervention on the academic self-concept of adolescent students with hearing impairment: Implications for physical education. *Medicine (United States)*, *99*(30), E21054. <https://doi.org/10.1097/MD.00000000000021054>
- Bangun, S. Y., Harahap, M. I., & Sihombing, R. S. D. (2023). Development of physical activity games in improving the physical motor ability of children aged 10-11 years at the elementary school level. *Jurnal Keolahragaan*, *11*(2), 191–201. <https://doi.org/10.21831/jk.v11i2.62106>
- Bodsworth, H., & Goodyear, V. A. (2017). Barriers and facilitators to using digital technologies in the Cooperative Learning model in physical education. *Physical Education and Sport Pedagogy*, *22*(6), 563–579. <https://doi.org/10.1080/17408989.2017.1294672>
- Bogdanovskaya, E. V., & Andreichenko, A. V. (2024). The use of technology in physical education of students: prospects and challenges. *Scientific and Educational Basics in Physical Culture and Sports*, *13*(1), 10–14. <https://doi.org/10.57006/2782-3245-2024-13-1-10-14>
- Bores-García, D., Cano-de-la-Cuerda, R., Espada, M., Romero-Parra, N., Fernández-Vázquez, D., Delfa-De-La-Morena, J. M., Navarro-López, V., & Palacios-Ceña, D. (2024). Educational Research on the Use of Virtual Reality Combined with a Practice Teaching Style in Physical Education: A Qualitative Study from the Perspective of Researchers. *Education Sciences*, *14*(3). <https://doi.org/10.3390/educsci14030291>
- Bornmann, L., & Leydesdorff, L. (2014). Scientometrics in a changing research landscape. *EMBO Reports*, *15*(12), 1228–1232. <https://doi.org/10.15252/embr.201439608>
- Brown, K., & Zhang, Z. (2024). Love and the Distance: The Role of Presence in Online Learning. *Canadian Journal of Education*, *47*(1), 59–85. <https://doi.org/10.53967/cje-rce.6163>
- Casey, A., Goodyear, V. A., & Armour, K. M. (2017). Rethinking the relationship between pedagogy, technology and learning in health and physical education. *Sport, Education and Society*, *22*(2), 288–304. <https://doi.org/10.1080/13573322.2016.1226792>
- Cristina NAE, I. (2024). *The Intersection of Sports with Technological Evolution*. <https://doi.org/10.24818/mrt>
- Diodato, V. P., & Gellatly, P. (2013). *Dictionary of Bibliometrics*. Routledge. <https://doi.org/10.4324/9780203714133>
- Ellegaard, O., & Wallin, J. A. (2015). The bibliometric analysis of scholarly production: How great is the impact? *Scientometrics*, *105*(3), 1809–1831. <https://doi.org/10.1007/s11192-015-1645-z>
- Filiz, G., Arman, N., Ayaz, N. A., Yekdaneh, A., Albayrak, A., Bozkan, T., & Çakar, T. (2024). Physical Activity Monitoring with Smartwatch Technology in Adolescents and Obtaining Big Data: Preliminary Findings. *2024 32nd Signal Processing and Communications Applications Conference (SIU)*, 1–4. <https://doi.org/10.1109/SIU61531.2024.10601111>
- Fogel, V. A., Miltenberger, R. G., Graves, R., & Koehler, S. (2010). The Effects of Exergaming on Physical Activity Among Inactive Children in A Physical Education Classroom. *Journal of Applied Behavior Analysis*, *43*(4), 591–600. <https://doi.org/10.1901/jaba.2010.43-591>
- Gil-Espinosa, F. J., López-Fernández, I., Espejo, R., & Burgueño, R. (2023). Physical Education Curricular Elements in Blended Learning During the COVID-19 Pandemic. *Journal of Teaching in Physical Education*, *42*(3), 525–534. <https://doi.org/10.1123/jtpe.2021-0265>
- Goodyear, V. A., Casey, A., & Kirk, D. (2014a). Hiding behind the camera: social learning within the Cooperative Learning Model to engage girls in physical education. *Sport, Education and Society*, *19*(6), 712–734. <https://doi.org/10.1080/13573322.2012.707124>
- Goodyear, V. A., Casey, A., & Kirk, D. (2014b). Tweet me, message me, like me: using social media to facilitate pedagogical change within an emerging community of practice. *Sport, Education and Society*, *19*(7), 927–943. <https://doi.org/10.1080/13573322.2013.858624>
- Goodyear, V. A., Kerner, C., & Quennerstedt, M. (2019). Young people's uses of wearable healthy lifestyle technologies; surveillance, self-surveillance, and resistance. *Sport, Education and Society*, *24*(3), 212–225. <https://doi.org/10.1080/13573322.2017.1375907>
- Gopika, J. S., & Rekha, R. V. (2023). Awareness and Use of Digital Learning Before and During COVID-19. *International Journal of Educational Reform*, 105678792311733. <https://doi.org/10.1177/10567879231173389>
- Hartman, R. J., Townsend, M. B., & Jackson, M. (2019). Educators' perceptions of technology integration into the classroom: a descriptive case study. *Journal of Research in Innovative Teaching & Learning*, *12*(3), 236–249. <https://doi.org/10.1108/JRIT-03-2019-0044>
- Huang, C., Yang, C., Wang, S., Wu, W., Su, J., & Liang, C. (2020). Evolution of topics in education research: a systematic review using bibliometric analysis. *Educational Review*, *72*(3), 281–297. <https://doi.org/10.1080/00131911.2019.1566212>
- Ibrahim, Z. S., Rifqiyah, F., Sultan, J., & Retnawati, H. (2023). A Visualized Bibliometric Analysis for Mapping Research Trends of Machine Learning in Academic Research. *Materials of International Practical Internet Conference "Challenges of Science,"* 271–279. <https://doi.org/10.31643/2023.34>
- Johnson, T. G. (2018). Team Sports Belong in High School Physical Education Programs. *Journal of Physical Education, Recreation & Dance*, *89*(9), 5–8. <https://doi.org/10.1080/07303084.2018.1516457>
- Julia, J., Afrianti, N., Soomro, K. A., Supriyadi, T., Dolifah, D., Isrokaton, I., Erhamwilda, E., & Ningrum, D. (2020). Flipped Classroom Educational Model (2010-2019): A Bibliometric Study. *European Journal of Educational Research*, volume-9-2020(volume-9-issue-4-october-2020), 1377–1392. <https://doi.org/10.12973/eu-jer.9.4.1377>

- Kerner, C., & Goodyear, V. A. (2017). The Motivational Impact of Wearable Healthy Lifestyle Technologies: A Self-determination Perspective on Fitbits With Adolescents. *American Journal of Health Education*, 48(5), 287–297. <https://doi.org/10.1080/19325037.2017.1343161>
- Lai, S. (2024). Optimization of Innovative Path of Physical Education Teaching in Colleges and Universities under Information Integration Technology. *Applied Mathematics and Nonlinear Sciences*, 9(1). <https://doi.org/10.2478/amns-2024-0767>
- Lobo, J., Prevandos, F. G., Tanucan, J. C., & Setiawan, E. (2024). Is Video-Conferencing Helpful for Physical Education Classes in the New Normal? A PLS-SEM Analysis Adopting the Technology Acceptance Model. *Journal of Learning for Development*, 11(1), 99–114. <https://doi.org/10.56059/jl4d.v11i1.1125>
- López Belmonte, J., Segura-Robles, A., Moreno-Guerrero, A.-J., & Parra-González, M. E. (2020). Machine Learning and Big Data in the Impact Literature. A Bibliometric Review with Scientific Mapping in Web of Science. *Symmetry*, 12(4), 495. <https://doi.org/10.3390/sym12040495>
- Lumbantobing, J. H. A., Siburian, D. L., Sinaga, B. D., Silalahi, P. A., & Nurkadri, N. (2024). The Influence of Digital Technology in Increasing the Effectiveness of Physical Education Learning in the Modern Era. *AURELIA: Jurnal Penelitian Dan Pengabdian Masyarakat Indonesia*, 3(2), 1254–1257. <https://doi.org/10.57235/aurelia.v3i2.2680>
- Luo, C. (2023). Design of sports multimedia teaching platform based on machine learning. *Soft Computing*. <https://doi.org/10.1007/s00500-023-09093-w>
- Mejia, C., Wu, M., Zhang, Y., & Kajikawa, Y. (2021). Exploring Topics in Bibliometric Research Through Citation Networks and Semantic Analysis. *Frontiers in Research Metrics and Analytics*, 6. <https://doi.org/10.3389/frma.2021.742311>
- Moreno-Guerrero, A.-J., Parra-González, M.-E., López-Belmonte, J., & Segura-Robles, A. (2021). Innovating in Nutrition Education: Application of Gamification and Digital Resources in High School Students. *Retos*, 43, 438–446. <https://doi.org/10.47197/RETOS.V43I0.87569>
- Narciso, H. A. A. (2023). Exploring the impact of E-infographics on teaching health optimizing physical education 2 in comparison to conventional methods. *Journal of Physical Education and Sport*, 23(9), 2376–2384. <https://doi.org/10.7752/jpes.2023.09273>
- Nurjanah, S., Sultan, J., Aisyah, S., Puspita, D., & Ulyasari, N. (2024). Bibliometric Analysis of Problem Based Learning in Physics Education: A Scopus Based Study (1996-2023). *Berkala Ilmiah Pendidikan Fisika*, 12(2), 310. <https://doi.org/10.20527/bipf.v12i2.18775>
- Oluwadele, D., Singh, Y., & Adeliyi, T. T. (2023). Trends and insights in e-learning in medical education: A bibliometric analysis. *Review of Education*, 11(3). <https://doi.org/10.1002/rev3.3431>
- Ospankulov, Y., Zhumabayeva, A., Nishanbayeva, S., Ussen, B., & Zhalel, A. (2023). The Effect of the Use of Digital Technologies in Physical Education Lessons on Students' Physical Education Cultures and Attitudes towards the Lesson. *International Journal of Education in Mathematics, Science and Technology*, 11(6), 1424–1442. <https://doi.org/10.46328/ijemst.3700>
- Öztürk, O., Kocaman, R., & Kanbach, D. K. (2024). How to design bibliometric research: an overview and a framework proposal. *Review of Managerial Science*. <https://doi.org/10.1007/s11846-024-00738-0>
- Ponce, P., López-Orozco, C. F., Reyes, G. E. B., Lopez-Caudana, E., Parra, N. M., & Molina, A. (2022). Use of Robotic Platforms as a Tool to Support STEM and Physical Education in Developed Countries: A Descriptive Analysis. *Sensors*, 22(3). <https://doi.org/10.3390/s22031037>
- Potdevin, F., Vors, O., Huchez, A., Lamour, M., Davids, K., & Schnitzler, C. (2018). How can video feedback be used in physical education to support novice learning in gymnastics? Effects on motor learning, self-assessment and motivation. *Physical Education and Sport Pedagogy*, 23(6), 559–574. <https://doi.org/10.1080/17408989.2018.1485138>
- Qian, Y. (2024). The Construction of Wisdom Teaching Mode of Physical Education and Training in Colleges and Universities in the Internet Era. *Applied Mathematics and Nonlinear Sciences*, 9(1). <https://doi.org/10.2478/amns-2024-0777>
- Quintas-Hijós, A., Peñarrubia-Lozano, C., & Bustamante, J. C. (2020). Analysis of the applicability and utility of a gamified didactics with exergames at primary schools: Qualitative findings from a natural experiment. *PLoS ONE*, 15(4). <https://doi.org/10.1371/journal.pone.0231269>
- Rabani, S., Khairat, A., Guilin, X., & Jiao, D. (2023). The Role of Technology in Indonesian Education at Present. *Journal of Computer Science Advancements*, 1(2), 85–91.
- Shamsi, A., Lund, B. D., SeyyedHosseini, S., & BasirianJahromi, R. (2023). Journal selection behavior among early-career academicians in Iran: how they choose the most appropriate journal for their publications. *Global Knowledge, Memory and Communication*, 72(3), 315–326. <https://doi.org/10.1108/GKMC-09-2021-0146>
- Tomar, V., & Soni. (2024). Impact of technology on education. *International Journal of Advanced Academic Studies*, 6(6S), 127–130. <https://doi.org/10.33545/27068919.2024.v6.i6b.1222>
- Vampugani, V. S., Swathi, K., Subrahmanyam, V. V., & Swathi, K. (2020). *Wearable Technology and its Role in Education*. [www.statista.com](http://www.statista.com)
- Varea, V., González-Calvo, G., & García-Monge, A. (2022). Exploring the changes of physical education in the age of Covid-19. *Physical Education and Sport Pedagogy*, 27(1), 32–42. <https://doi.org/10.1080/17408989.2020.1861233>
- Williamson, B. (2015). Algorithmic skin: health-tracking technologies, personal analytics and the biopedagogies of digitized health and physical education. *Sport, Education and Society*, 20(1), 133–151. <https://doi.org/10.1080/13573322.2014.962494>
- Winter, E., Costello, A., O'Brien, M., & Hickey, G. (2021). Teachers' use of technology and the impact of Covid-19. *Irish Educational Studies*, 40(2), 235–246. <https://doi.org/10.1080/03323315.2021.1916559>