https://africanjournalofbiomedicalresearch.com/index.php/AJBR
Afr. J. Biomed. Res. Vol. 28(1) (January 2025); 40- 54
Research Article

Systematic Mapping Review on Mobile Apps Integration in Physical Education: Implications for Health, Training, And Teacher Support

Syed Mohd Najib Syed Yahya[1], Khairul Azhar Jamaludin[2*], Nur Shakila Mazalan[3,]

[1]Faculty of Education, Universiti Kebangsaan Malaysia. 43600 Bangi, Selangor, Malaysia,
E-mail: p121434@siswa.ukm.edu.my, Orcid ID: 0009-0000-6472-5391
[3]Faculty of Education, Universiti Kebangsaan Malaysia. 43600 Bangi, Selangor, Malaysia,
E-mail: shakila@ukm.edu.my, Orcid ID: 0000-0001-7399-1683

***Corresponding author:** Khairul Azhar Jamaludin
[2*]Faculty of Education, Universiti Kebangsaan Malaysia. 43600 Bangi, Selangor, Malaysia.
E-mail: khairuljamaludin@ukm.edu.my, Orcid ID: 0000-0001-9709-6261

ABSTRACT
This systematic mapping review examines mobile application integration in physical education, assessing benefits, challenges, and the impact on health, training, and instructional support. Using PRISMA guidelines, the review analyzed 50 articles from the last six years. This review identifies four main categories of apps related to physical education: educational support in teaching and learning, wellness training, assessment and measurement, and classroom management and monitoring. Findings show that mobile apps significantly influence student health behaviors, teacher practices, and educational outcomes. However, challenges such as teacher resistance, limited digital skills, and practical barriers affect broader adoption. This review highlights the potential of mobile apps to improve health through physical education and enhance teacher effectiveness. It recommends further development of apps that prioritize health metrics and create accessible support systems for teachers, offering a sustainable approach to tech-enhanced physical education. The study provides insights into how technology intersects with health education, fostering discussion on innovative tools for better physical and educational outcomes.

Keywords: Integration, Physical Education, Mobile Application, Teacher, Review

**Authors for correspondence: E-mail Id: khairuljamaludin@ukm.edu.my*

Received:01/11/2024 Accepted:07/11/2024

DOI: https://doi.org/10.53555/AJBR.v28i1.3085

1.0 INTRODUCTION

In recent years, the integration of technology into various educational domains including physical education (PE) has gained considerable traction. Among the diverse array of digital tools available, mobile applications (apps) have emerged as promising resources for transforming traditional teaching practices and enhancing student engagement (Chen, 2024; Baek, 2020; Yu et al., 2018). However, empirical evidence on the diverse integration of mobile apps in physical education is limited (Noraini, 2024; Jastrow et al., 2022).

The use of mobile apps in PE holds significant promise for addressing several longstanding challenges faced by teachers. These challenges include providing academic achievement, timely feedback, managing individualized instruction, and fostering student motivation and learning experience (Rezaee, 2024; Noraini, 2024; Vega-Ramírez et al., 2020). In addition, the attitude and perspective of teachers towards technology, lack of knowledge and experience in the use of sports apps, teachers as active learners, implementation of PE curriculum, and taking a long time to build apps a part of the challenges (Beni et al., 2021; Yu, 2020; Adams, 2023). Nevertheless, concerns persist regarding the complexity and practicality of integrating mobile technology into PE curricula hindering widespread adoption among educators (Khudhair et al., 2024).

Against this backdrop, this review paper aims to critically examine the utilization of mobile apps in physical education and impact to teachers support. By synthesizing existing research and identifying key themes and trends, this review seeks to provide insights about opportunities to overcome challenges associated with mobile technology integration. As such, this review will be able to affect the integration of mobile apps into teachers' instructional practices and overall pedagogical effectiveness. This article used a systematic mapping review to comprehensively see globally the facts and data related to the integration of mobile apps in PE.

2.0 RESEARCH DESIGN

The present study employed the systematic mapping review methodology utilizing PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analyses) as a framework for guidance. The present study employed a systematic research approach to identify and locate scholarly articles pertaining to the integration of mobile apps in teaching in the context of physical education. Multiple databases are used for this purpose including Web of Science (WoS), Scopus, and Science Direct. Subsequently, the systematic procedure persisted encompassing several stages including identification, screening, assessment of eligibility, and exclusion (Moher et al., 2009).

2.1 The Review Protocol (PRISMA)

The PRISMA framework is frequently utilized within the realm of educational research. PRISMA as identified by Sierra-Correa and Cantera Kintz (2015) presents three distinct advantages. Firstly, it facilitates the formulation of precise research inquiries thereby promoting systematic investigation. Secondly, it establishes criteria for inclusion and exclusion to ensure methodological rigor. Lastly, it provides researchers with access to an extensive repository of scientific literature to enable comprehensive analysis. The PRISMA framework offers researchers the ability to systematically and rigorously search for relevant literature pertaining to mobile apps in the context of physical education and teaching. The aforementioned methodology is utilized for the purpose of discerning the utilization of mobile apps within the realm of physical education, specifically targeting teachers.

2.2 Resources

The study highlights two main databases (WoS and Scopus) and one supporting database (Science Direct). The study use the WOS database because WOS is a robust database comprising about 33,000 journal articles and covering more than 256 disciplines including the subjects related to environmental studies, interdisciplinary social sciences, social issues, as well as development and planning. The second database used in this systematic literature review was Scopus which consists of 22,800 journals from 5000 publishers all over the world. The study uses Scopus databases because Scopus is one of the largest abstract and citation databases including peer-reviewed literature. It also covers a wide range of subject areas such as environmental sciences, social science, agriculture, and biological sciences.

The third database used in this study was Science Direct because it is an open-access database containing 1.4 million articles. There are three main categories of journals in this database namely social science and humanities, health sciences, life sciences, as well as physical sciences and engineering. Overall, the selection of these three database resources has covered all data needed in these topics to be discussed comprehensively and will eliminate other database resources.

2.3 Systematic Searching Strategies

There are three main stages in the systematic searching strategies namely identification, screening, and eligibility (see Figure 1).

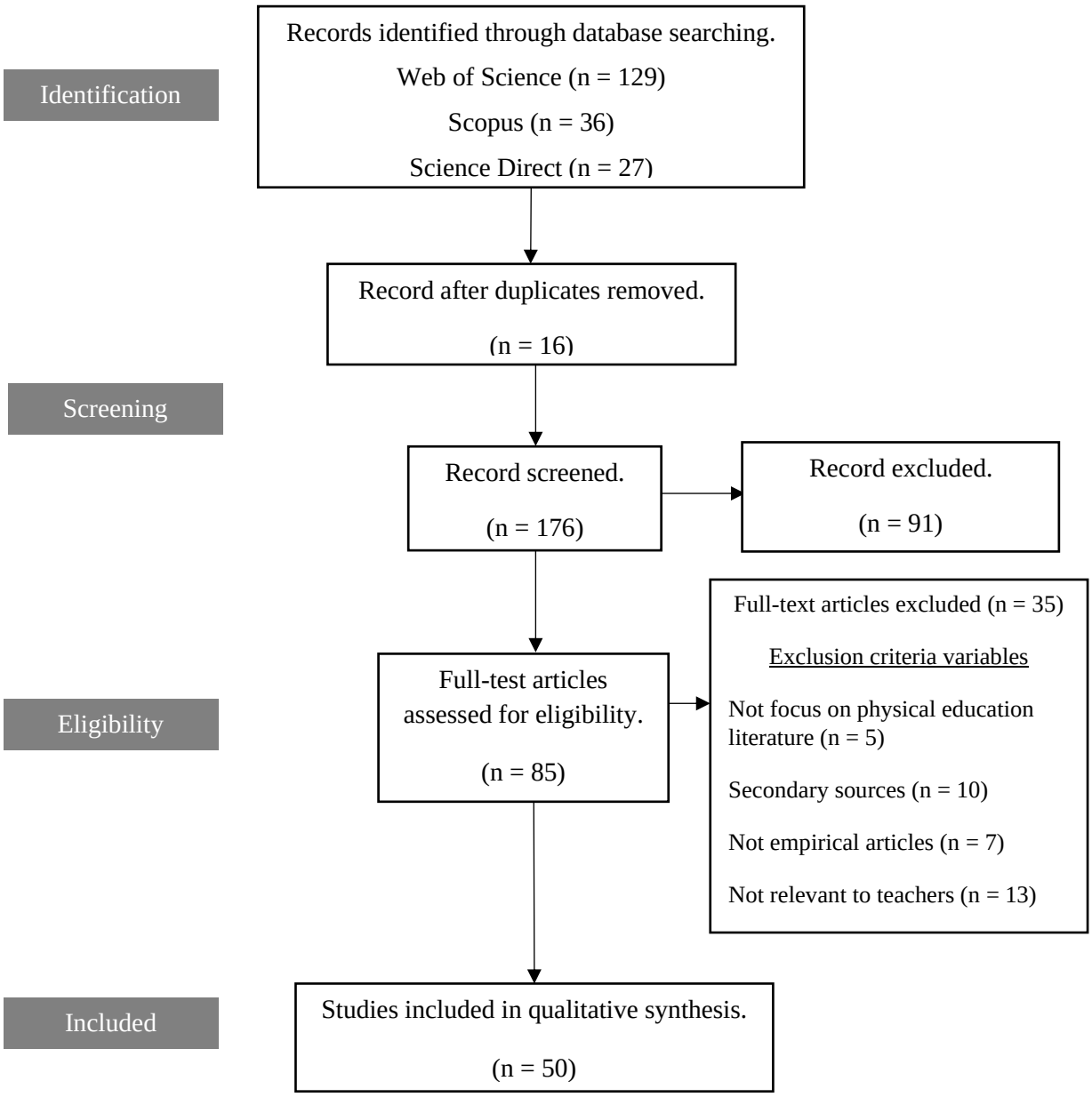

Fig 1: Flow diagram of the study.

2.4 Identification

The first phase is the process of identifying and finding related terms, synonyms, and variations for the main keywords for the study. The purpose of this stage is to provide more alternatives for the identified database to search for more relevant articles to be included in the systematic review. This process relied on keywords used by previous studies and keywords suggested by the database. Furthermore, the keywords were developed according to the research question as recommended by Okoli (2015). For this study, keywords are related to mobile apps for Teaching in Physical Education. Boolean operators, phrase searching, and truncation were used by the authors on the database particularly Scopus and Web of Science to enrich the current keywords and produce the full search string. Keywords similar and related to mobile apps, physical education, and teachers were used as shown in Table 1. Both Scopus and Web of Science are considered the leading databases in this review because they are comprehensive and have advanced search functions. Moreover, these two databases have a multidisciplinary focus and can control the quality of the articles (Gusenbauer & Haddaway, 2020; Martín-Martín et al., 2018). A total of 192 articles were retrieved from the searching process through Scopus, Web of Science, and the other one supporting databases (Science Direct).

Table 1 The search string used for the systematic review process.

Database	Keyword Used
Scopus	TITLE-ABS-KEY ("Mobile Applications" OR "Mobile Apps" AND "Physical Education" AND "Teacher")
Web of Science	(((ALL=(mobile application)) OR ALL=(mobile apps)) AND ALL=(physical education)) AND ALL=(teacher)
Science Direct	"Mobile Applications" OR "Mobile Apps" AND "Physical Education" AND "Teacher"

2.5 Screening

A comprehensive search was conducted to identify duplicate articles within all databases used and these articles were excluded from the analysis. This was followed by a thorough analysis of the remaining articles to determine if they fulfill the criteria. The process of article selection involved the application of predetermined criteria to a total of 192 articles (see Table 2). This selection process was carried out automatically within the database using a sorting method.

The findings of the search conducted on the selected database revealed a substantial body of research conducted on mobile apps in the field of physical education commencing from the year 2014. Nevertheless, there exists a dearth of comprehensive systematic reviews pertaining to the post-2018 period. Consequently, the time frame spanning from 2018 to 2023 was selected as one of the criteria for inclusion. The review exclusively incorporated studies that possessed empirical data and had been published in a scholarly journal to ensure the review's credibility and reliability. In addition, this review specifically focused on articles pertaining to mobile apps, physical education, and teachers. The application of this methodology led to the elimination of 16 replicated articles and the exclusion of 91 articles that did not satisfy the predetermined criteria for inclusion.

Table 2 Eligibility and exclusion criteria

Criterion	Eligibility	Exclusion
Timeline	**Between 2018 to 2023**	**<2018**
Literature type	**Empirical**	**Systematic reviews, books, chapters in a book, conference proceedings**
Scope	**Related to mobile apps and physical education and teachers**	**Not related to mobile apps and physical education and teachers**

2.6 Eligibility

As for the third stage known as eligibility, a total of 85 articles were prepared. On a more important note, the titles, abstracts, and main contents of all articles were thoroughly examined at this stage to ensure that they met the inclusion criteria (see Table 2) and were suitable for use in the current study to meet the research objectives. As a result, 35 articles were eliminated since they were not related to empirical data and physical education context. Finally, 50 articles were ready to be examined.

2.7 Exclusion

Only research articles that truly met the criterion were included after the three steps. That article's approach included quantitative, qualitative, and mixed methods research. Book, book series, chapters in the book, systematic review articles, conference proceedings, publications published before 2018, and non-physical education articles were all essential points for exclusion. All these factors were considered to generate high-quality data and have illustrated the procedure followed (see Figure 1).

2.8 Analysis process

We used content analysis techniques as suggested by Krippendorff (2018) to identify patterns in the article's research questions, methods, and findings. By uncovering patterns in research methods and topics of study, we were able to synthesize findings across sources to illustrate the current state of research in this area and to suggest areas for development. This method of analysis aligns with the methods of a "mapping review" as suggested by Grant and Booth (2009) because it attempts to characterize a set of literature based on its key features. Such reviews provide a contextualization of research within an established group of literature and can lay the foundation for further in-depth reviews of literature. Studies from 50 articles with various research approaches such as quantitative, qualitative, and mixed methods include empirical research on the integration of mobile apps in teaching physical education subjects (see Figure 2).

The diversity of these types of empirical study articles makes our analysis extensive and provides in-depth data on teacher teaching in physical education. This can help to better define practices and frameworks to guide teacher preparation. In addition, the analysis can also identify the most used themes for research related to the integration of mobile apps in teaching physical education and its impact on curriculum implementation.

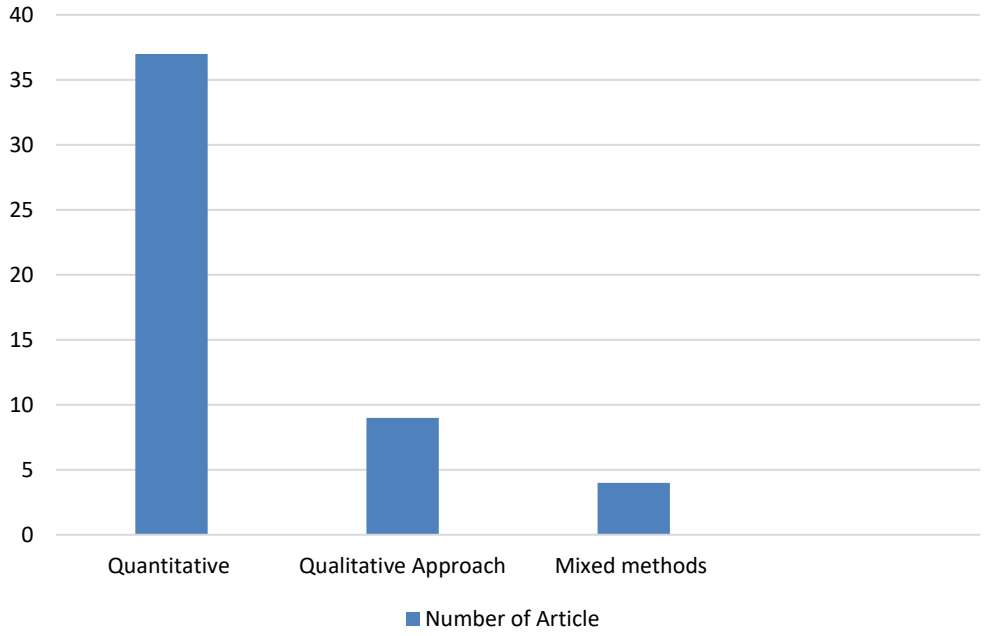

Fig 2: Research Approach

3.0 RESULTS AND ANALYSIS

A total of 50 articles were acquired through the process of this review. The study identified four overarching themes related to mobile apps in physical education which are teaching and learning applications, training and health applications, measurement and assessment applications, and management and monitoring applications. Besides that, a comprehensive analysis of the four themes was conducted focusing on the analysis of periodicals published journals and distribution of publications between countries as well as the impact of integration in the implementation of the physical education curricula based on emerging themes.

3.1 Articles Reviewed Based on Journals

The analysis of publication trends from 2018 to 2023 reveals a significant increase in articles focusing on integrating mobile apps into teaching physical education. Publication peaked in 2022 before a slight decline in 2023 which is possibly due to ongoing publication processes (see Table 3). This trend reflects a growing interest and engagement within the academic community as evidenced by publications across diverse journals such as Teoriya i Praktika Fizicheskoy Kultury and Journal of Physical Education and Sport. The international representation across various journals underscores the global relevance and applicability of findings and shows widespread interest in leveraging mobile technology for teaching physical education across different cultural and educational contexts. Certain journals emerged as prominent venues for such research highlighting their significance in advancing knowledge in this area. Overall, these findings demonstrate the dynamic and evolving research landscape in integrating mobile apps into physical education teaching while emphasizing the interdisciplinary nature and widespread impact.

Table 3 Articles reviewed based on journals.

Journal	2018	2019	2020	2021	2022	2023
Teoriya i Praktika Fizicheskoy Kultury	1	1	1	4	1	
Journal of Physical Education and Sport				2		
Education and Information Technologies						1
International Journal of Interactive Mobile Technologies			1		1	
International Journal of Environmental Research and Public Health			1			
Scandinavian Journal of Medicine and Science in Sports				1		
Retos			1		1	
Education Sciences			2			
Revista de Psicologia del Deporte			1			
Journal of Sustainability Science and Management						1
Applied Sciences (Switzerland)					1	
Aloma					1	
Journal of Teaching in Physical Education					1	
Lecture Notes in Electrical Engineering					1	
Children					1	

Wireless Communications and Mobile Computing					1	
Pixel-Bit, Revista de Medios y Educacion					1	
Revista Brasileira de Ciencias do Esporte					1	
Research in Sports Medicine					1	
Sustainability (Switzerland)					2	
International Journal of Human Movement and Sports Sciences					1	1
European Journal of Special Needs Education		1		1		
European Physical Education Review				1		
International Journal of Advanced Computer Science and Applications				1		
Journal of Physical Education, Recreation and Dance						1
Asian Journal of University Education				1		
Medicine (United States)			1			
JMIR Formative Research			1			
Cultura, Ciencia y Deporte			1			
JMIR mHealth and uHealth			1			
Physical Education and Sport Pedagogy			1			
Sport, Education, and Society		1				
Revista Andaluza de Medicina del Deporte		1				
Interactive Learning Environments		1				
Physician and Sportsmedicine	1					
Strategies	1					
Total	3	5	12	11	15	4

3.2 Distribution of Articles Based on Countries

This distribution reveals fluctuations in the quantity of published materials annually from 2018 to 2023 with notable increases in 2020 and followed by a decrease in 2023 (see Table 4). Spain and the Russian Federation emerged as leading contributors in demonstrating sustained interest and investment in research on mobile technology in physical education. While countries like the United States and Greece show intermittent contributions, it shows the diverse efforts of research endeavors in various countries. Additionally, articles from countries such as Australia, Brazil, Canada, and China demonstrate global recognition of the potential benefits of integrating mobile apps into physical education. The inclusion of articles from Malaysia, South Korea, the Philippines, and Indonesia reflects a growing interest in technology-enhanced teaching methods across diverse cultural and educational contexts. Moreover, the presence of articles from countries like Ireland, Sweden, Portugal, and Thailand suggests broader engagement with the topic worldwide. This geographic diversity underscores the global significance of research on integrating mobile apps in teaching physical education while highlighting the widespread interest and diverse perspectives shaping this evolving field.

Table 4 Distribution of articles based on countries.

Journal	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Russian Federation	1	1	1	4	1	
Spain		1	4	1	5	1
United States			1		1	1
Greece			1	2		
Ireland				1		
Australia		1		1		
Sweden		1				
Brazil		1			1	
Canada			1		1	
China					2	
Malaysia				1		1
Lithuania						
South Korea			2			
Portugal						
Philippines					2	
Czech Republic					1	
Latvia						
Serbia			1			
Netherlands	1					
Taiwan	1					

Thailand			1			
Peru				1		
Indonesia						1
Romania					1	
Total	3	5	12	11	15	4

3.3 Latest Findings on the Integration of Mobile Apps in Physical Education

This section describes the four major finding's themes based on information from articles related to the integration of mobile apps in physical education. Details from the articles were coded in initially grouped based on similar concepts and findings. The codes categories included related to the four major themes to develop which are teaching and learning, training and health, measurement and assessment, and management and monitoring (See Table 5). The themes were validated by comparing them against the data extracted from the articles. Any discrepancies were resolved to ensure the themes were robust and comprehensive. Based on the four themes analyzed in this systematic review, were cross-referenced with the original articles to ensure they were supported by multiple sources and represented a significant aspect of the data. The following subtopics describe each theme of mobile app integration of physical education as well as their impact on teacher support.

Table 5 Latest Findings on the Integration of Mobile Apps in Physical Education.

Author and Year	Study Design	Teaching & Learning	Training & Health	Measuring & Assessment	Management & Monitoring
Zhang et. al. 2023	QL	/			
Mateo-Orcajada et. al. 2023	QN			/	
Sultoni et. al. 2023	QN			/	
Zulkifli & Danis 2023	QL	/			
Alonso-Fernández et. al 2022	QN			/	
Ben et. al. 2022	QN				/
Caputo et. al. 2022	QN			/	
Cojocaru et. al. 2022	QN				/
de Oliveira & Fraga 2022	QL		/		
Díaz-Barahona et. al. 2022	QN		/		
Manĕnová et. al. 2022	QN	/			
Martínez-Hita et. al. 2022	QN	/			
Saucedo-Araujo et. al. 2022	QL	/			
Semsem & Martin 2022	MM			/	
Shutova et. al 2022	QN			/	
Tolentino et. al 2022	MM		/		
Yu & Fei 2022	QN	/			
Yu et. al. 2022	QN			/	
Alvarez-Herrero et. al. 2022	QN		/		
Bobkov et al. 2021	QN				/
Calderón & Tannehill 2021	QL	/			
Ng et. al 2021	QN				/
Shmeleva et. al 2021	QN	/			
Papastergiou et. al 2021	QN				/
Papastergiou et. al 2021	QN		/		
Shutova et. al 2021	QN				/
Surova et. al 2021	QN		/		
Lee et. al. 2021	QN			/	
Zulkifli & Danis 2021	QL			/	
Diaz-Nunez et. al 2021	QN	/			
Brown et. al 2020	MM		/		
Michalakis et. al. 2020	QN	/			
Arroyo & Royuela 2020	QN	/			
Baek et. al 2020	QN		/		
Bogataj et. al 2020	QN			/	
Chaichitwanidchakol & Feungchan 2020	QN	/			
Gil-Espinosa et. al 2020	QN	/			

Kim et. al. 2020	MM		/		
Lee & Gao 2020	QN	/			
Shutova & Andryushchenko 2020	QN		/		
Ruiz et. al. 2020	QN	/			
Vega-Ramírez et. al. 2020	QN	/			
Azevedo et. al. 2019	QL			/	
Chiang et. al. 2019	QN	/			
Goodyear et. al. 2019	QL		/		
Hartwig et. al. 2019	QN				/
Zhigareva et. al 2019	QL				/
Cheng & Chen 2018	QN			/	
Kemler et. al. 2018	QN		/		
Minkin et. al. 2018	QN		/		
Total		17	13	12	8

*QN = Quantitative, QL = Qualitative, MM = Mixed Method.

The analysis encompassed 50 articles revealing a predominance of quantitative study designs alongside qualitative and mixed-method approaches. It reflects a comprehensive exploration of mobile app integration in physical education. Finding shows Teaching and learning themes emerged as the most extensively researched area, emphasizing technology's pivotal role in reshaping instructional practices and student engagement. The theme of training and health underscores a growing recognition of mobile apps for promoting physical activity and wellness which is signaling a shift towards holistic approaches in physical education. However, themes like measuring and assessment, and management and monitoring received comparatively less attention, and these are potential areas for future research and intervention development. Overall, all the themes of the study covered various dimensions in the implementation of the physical education curriculum, and the details of each theme in depth can be understood through the details of the type of mobile apps in each theme.

i) ***Teaching and Learning***

In terms of teaching and learning, the findings describe that mobile apps have an impact on teaching and learning in physical education such as helping to facilitate the transmission of information, fostering a dynamic learning environment, and enhancing student involvement in these disciplines. Six types of apps impact teaching and learning that can help teachers and students (see Table 6). These include mobile app types of performance and motor skills, curriculum content, sports games, support for autistic children, physical activity, and helpful communication.

Table 6 Types of mobile apps in teaching and learning.

No	Author and Year	Teaching and Learning
1	Zulkifli & Danis 2023 Martínez-Hita et.al 2022 Yu & Fei 2022 Maněnová et.al 2022 Saucedo-Araujo et.al 2022	Performance & Motor skills
2	Calderón & Tannehill 2021 Michalakis et. al. 2020 Arroyo & Royuela 2020 Lee & Gao 2020 Ruiz et. al. 2020 Vega-Ramírez et. al. 2020	Curriculum content
3	Chiang et. al. 2019	Sports games
4	Chaichitwanidchakol & Feungchan 2020	Support autistic children
5	Zhang et. al. 2023 Shmeleva et. al 2021 Gil-Espinosa et. al 2020	Physical activity
6	Diaz-Nunez et. al 2021	Helpful communication

The analysis places notable emphasis on improving performance and motor skills through mobile apps. Findings indicate that integration can enhance physical competencies among learners (Zulkifli & Danis, 2023; Yu & Fei, 2022). Findings also focus on delivering curriculum content through mobile apps as well as adding traditional teaching materials and enriching the learning experience (Calderón & Tannehill, 2021; Michalakis et al., 2020). Moreover, mobile apps are recognized for their ability to support diverse learners including autistic children with underscoring inclusive educational practices (Chaichitwanidchakol &

Feungchan, 2020). Additionally, attention is given to using mobile apps to engage students through sports games as a shift towards gamified learning approaches (Chiang et al., 2019). Furthermore, several studies emphasize the role of mobile apps in promoting physical activity and healthy lifestyles because they align with the objectives of physical education (Shutova et al., 2021). Lastly, studies highlighting effective communication through mobile apps underscore their contribution to creating supportive learning environments conducive to student success. Despite these findings, there are gaps in the research that need to be addressed. For instance, limited research on sports games, communication, and autistic content. This is a need to explore the research and integration of mobile apps in this part (Chiang et al., 2019).

ii) ***Training and Health***

Findings underscore the multifaceted types of mobile apps in promoting various aspects of student well-being and training effectiveness in physical education. Firstly, technology empowers self-optimization by enabling students to set goals and track progress as evidenced by de Oliveira & Fraga (2022). Secondly, mobile apps combat body stereotypes and foster positive body image as discussed by Díaz-Barahona et al. (2022). Moreover, integration can enhance movement competency training (Tolentino et al., 2022) and support healthy dietary habits (Alvarez-Herrero et al., 2022; Brown et al., 2020). Mobile apps also provide demonstrations of exercises (Papastergiou et al., 2021b) and enable distance training to be implemented (Surova et al., 2021). Furthermore, it can be performing self-directed exercise (Baek et al., 2020; Kim et al., 2020; Kemler et al., 2018), access to professional training services (Shutova & Andryushchenko, 2020) and promote holistic wellness (Goodyear et al., 2019). Other than that, findings show limited study specifically on teachers support for training rather than student. According to Wang and Yu (2022), exploration on integration technology for teacher training should be widely to increase the level of teachers in training. Overall, these findings highlight technologies as an important role in enhancing training effectiveness, health awareness, and overall well-being within physical education programs (see table 7).

Table 7 Types of mobile apps in training and health.

No	Author and Year	Training and Health
1	de Oliveira & Fraga 2022	Self-optimization
2	Díaz-Barahona et.al 2022	Body stereotypes
3	Tolentino et.al 2022	Movement competency training
4	Alvarez-Herrero et. al. 2022 Brown et. al 2020	Diet and nutrition
5	Papastergiou et. al. 2021	Demonstrating
6	Surova et. al 2021	Distance training
7	Baek et. al 2020 Kim et. al. 2020 Kemler et. al. 2018	Self-exercise and physical activity
8	Shutova & Andryushchenko 2020	Professional services training
9	Goodyear et. al. 2019	Healthy lifestyle
10	Minkin et. al. 2018	Training assistance

However, beyond presenting diverse types of mobile apps in this theme, the studies reveal that professional training can be done through mobile apps. This means that mobile apps also can be used for training wide to all things in the education system and not only for physical training such as counter physical education teachers' problems which as lack of knowledge, teaching skills, and motivation (Zhou, 2023; Chen & Dong, 2022).

iii) ***Measurement and Assessment***

The analysis of measurement and assessment applications in physical education reveals several research which are level of physical activity, level of physical fitness, body composition, movement techniques, and motor skills, sports injury, and level of health (see table 8). These findings show the role of mobile apps can tracking physical activity levels among users as shown in studies by Sultoni et al. (2023) and Caputo et al. (2022). Other than that, findings highlight the use of technology for assessing physical fitness parameters that are exemplified by Alonso-Fernández et al. (2022) and Semsem & Martin (2022). Additionally, the research emphasizes the significance of mobile apps in evaluating body composition as demonstrated by Mateo-Orcajada et al. (2023) and Shutova et al. (2022). Moreover, attention is given to assessing movement techniques and motor skills as seen in studies by Yu and Ha (2021), Zulkifli & Danis (2021), Bogataj et al. (2020), and Azevedo et al. (2019). Further, the analysis discusses the role of mobile apps in managing sports injuries as highlighted by Lee et al. (2021). Lastly, there's recognition of technology's potential in assessing overall health levels as indicated by Cheng and Chen (2018). Despite these findings, measurement and assessment are limited to assessing teacher aspects and it's will one of the further actions to focus on teaching assessment (Lonsdale et al., 2015). Overall, these findings illustrate the multifaceted role of mobile apps in enhancing assessment practices and promoting student well-being in physical education.

Table 8 Types of mobile apps in measurement and assessment.

No	Author and Year	Measurement & Assessment
1	Sultoni et.al 2023 Caputo et.al 2022	Level of physical activity
2	Alonso-Fernández et. al 2022 Semsem & Martin 2022	Level of physical fitness
3	Mateo-Orcajada et.al 2023 Shutova et.al 2022	Body composition
4	Yu et. al. 2022 Zulkifli & Danis 2021 Bogataj et. al 2020 Azevedo et. al. 2019	Movement techniques and Motor skills
5	Lee et. al. 2021	Sport injury
6	Cheng & Chen 2018	Level of health

These studies often revolve around app accessibility, teacher competency, and the infrastructure needed to effectively integrate mobile technology. Measurements and assessments also can be done for teachers and students by easily using mobile apps such as focus on pedagogy and competency improvement as well as achievement on knowledge, psychomotor, and affective.

iv) *Management and Monitoring*

The findings regarding the integration of management and monitoring applications in physical education reveal a multifaceted approach to leveraging mobile technology (see table 9). Notably, there's an emphasis on streamlining sports activities management, optimizing teaching and learning practices, and facilitating self-training sessions as evidenced by studies by Ben et al. (2022) and Cojocaru et al. (2022). Moreover, there's a focus on promoting inclusive practices through adapted physical education, as demonstrated by Ng et al. (2021), and on encouraging healthy lifestyles via nutrition monitoring tools as exemplified by Papastergiou et al. (2021a). Additionally, the role of mobile apps in tracking body composition and fitness data has the potential in facilitating fitness goals as well as being able to improve overall health outcomes in physical education (Shutova et al, 2021). Other than that, monitoring for teacher implementation of PE curriculum is not included in any study, and it will be valuable for increasing quality of physical education by giving interest for teachers to integrate the technology (Vega-Ramírez et. al. 2020). Overall, findings show more study was focused on management and monitoring mobile apps in physical education and it facilitates to deliver physical education curriculum.

Table 9 Types of mobile apps in management and monitoring.

No	Author and Year	Management and Monitoring
1	Ben et.al 2022 Hartwig et. al. 2019	Sports activities
2	Cojocaru et.al 2022	Teaching and learning practice
3	Bobkov et al. 2021	Self-training session
4	Ng et. al 2021	Practices skills in adapted physical education
5	Papastergiou et. al 2021	Nutrition monitoring
6	Shutova et. al 2021	Body composition
7	Zhigareva et. al 2019	Performance data

On the other side, studies show mobile apps also can manage and monitor teachers and students with real-time feedback and make them alert to all the tasks given. These tools can be useful if teachers and students can manage behavior to that change and with mobile apps also, they all can self-monitor the tasks that are given.

4.0 DISCUSSION

The integration of mobile apps in physical education gives a benefit and challenges for teachers to deliver this curriculum and will impact all teachers and students positively and negatively based on the findings. Findings show that the utilization of mobile apps has been extensively adopted in numerous countries over the last six years. It is noteworthy that a significant number of countries such as Maldives (Abdulla et al., 2022a), Croatia (Milić et al., 2022), Cyprus (Kyriakides & Tsangaridou, 2017), Canada (Barber et al., 2022), the United Kingdom (McEvilly, 2022), Japan (Kihara et al., 2021), and several others that employ generalist teachers or education teachers to deliver physical education instruction. This demonstrates that mobile app technology will have an impact if not overcome correctly because studies show more teachers lack attitude and perspective towards technology and lack knowledge and experience in the use of sports apps (Yu, 2020). Therefore, mobile apps are currently the most appropriate instrument to address the challenges of physical education teachers including generalist teachers

in the field of physical education and they should be extensively employed.

Research indicated that the utilization of mobile apps has the potential to augment the pedagogical abilities of physical education teachers including generalist and expert teachers. The assertion that the integration of mobile technology in physical education can enhance instructional effectiveness has been substantiated by numerous studies (Cojocaru et al., 2022; Kerner & Goodyear, 2017). Furthermore, mobile apps afford individuals a chance to enhance their learning proficiency and cultivate their autonomy in the acquisition of knowledge (Yu & Ha, 2021). This is due to the absence of temporal and spatial constraints that enable a seamless and interrupted learning experience (Romero-Ramos et al., 2022). Thus, new designs for teaching content especially in sports games, autistic content, and communication support for teachers should be explored in another study for a new integration of mobile apps and it will enhance knowledge, attitude, and motivation for teachers and students (Yu & Fei, 2022; Ng, K et. al. 2021).

Furthermore, another area of concern is the ability of teachers to effectively address issues related to training and health within the context of physical education. The efficacy of mobile apps proves that they can enhance student fitness training performance within the context of physical education subjects as facilitated by teachers. The mobile apps also address the issue of training implementation by enabling students to repeatedly access and review the training materials as well as reducing the need for teachers to physically demonstrate behavioral or motor skills (Papastergiou et al., 2021b). Mobile apps have the potential to offer training skills for physical activity as they can be utilized during leisure time (Böhm et al., 2019; Brickwood et al., 2019; Gil-Espinosa et al., 2020). Furthermore, Romero-Ramos et al. (2022) contend that the implementation of a teacher training center on the m-learning approach is crucial in ensuring concrete outcomes among students. Therefore, mobile apps in the future should focus on inserting guides and videos to demonstrate for teachers to address issues in the teaching process and overcome them in the right way. According to Shmeleva et al. (2021), integration effectiveness in mobile apps must optimize digital technology like video because findings show that learning from video is most common for users.

Moreover, the findings have revealed that mobile apps possess the capability to measure and evaluate diverse aspects of physical education. A range of measurements and assessments can be conducted to evaluate different aspects such as student academic advancement, physical fitness, motor skills, and body composition. The implementation of this intervention is expected to enhance the proficiency of teachers in evaluating student performance in the domain of physical education. Mobile apps also facilitate the ongoing collection of student performance data, the monitoring of individual progress, and the provision of suitable feedback (Papastergiou et al., 2021a; Yu, 2020; Zvyagina et al., 2021). This utilization of mobile apps for measurements in the curriculum physical education aspect can assist teachers in assessing students and enhancing student achievement. The measurement for the teaching aspect also can be focused on future research because it is limited to previous studies. This is important because measuring teachers will help teachers to improve their quality of teaching, especially generalist teachers who lack teaching skills (Barber et al., 2022).

The mobile apps also offer a variety of significant advantages to teachers enhancing their skills in managing physical education. The incorporation of these mobile apps which focus on management and monitoring has the potential to be utilized in diverse domains including sports activities, educational instruction, training sessions, and other relevant areas. Its primary objective is to enhance teachers' ability to effectively manage these aspects. Regarding the domain of education, the utilization of the application can facilitate educators in devising lessons that possess enhanced dynamism and diversity (Cojocaru et al., 2022). Furthermore, in the context of training sessions, the application aids in the autonomous monitoring of student training sessions and empowers teachers to select suitable novel methodologies before instructing students (Shutova et al., 2021). According to Papastergiou et al. (2021a), mobile apps possess the ability to monitor the nutritional status and body composition of students and thereby enabling educators to offer more informed guidance on matters of nutrition and physical well-being. In general, the administration of these mobile apps provides significant advantages for generalist teachers in enhancing their proficiency in physical education.

Based on the findings of this study on the advantages of mobile apps for physical education teachers, educational institutions and policymakers should prioritize the inclusion of technology training within teacher professional development initiatives with particular emphasis on physical education teachers, especially generalist teachers. This is because one of the primary challenges encountered by generalist teachers pertains to their limited exposure to teaching physical education which subsequently leads to the implementation of insufficient physical fitness activities (Abdulla, 2022b; Yon & Saraç, 2022). Furthermore, it is imperative to offer continuous assistance and access to educational materials to empower educators as they strive to enhance their technological skills and proficiency in utilizing these tools to improve teaching methods and facilitate student learning experiences within the domain of physical education.

This discussion and study have several limitations. Several factors impose constraints or limitations that must be considered when evaluating these findings. The study primarily concentrated on sources that were published within the preceding six-year period. This phenomenon may result in the exclusion of pertinent sources from previous years. This constraint presents novel prospects for forthcoming investigations, particularly regarding the utilization of mobile apps in the context of physical education. Furthermore, the present study was conducted utilizing articles sourced from reputable high-impact journals such as Web of

Science and Scopus as well as one supplementary database namely Science Direct. Hence, it is plausible that the outcomes could exhibit slight variations if alternative databases such as Google Scholar and Dimension.ai were employed in this study. Furthermore, it is important to consider that the evaluation of mobile app utilization in the context of physical education can be subject to the influence of cultural and geographical variables. The present study did not investigate potential variations in app usage across different countries or regions. Potential areas of investigation in future research may encompass the comparative analysis of mobile app utilization within the context of physical education across diverse nations with a particular focus on discerning disparities in usage patterns, obstacles encountered, and overall efficacy.

5.0 CONCLUSION

This systematic review presented an overview of empirical evidence on the development of mobile apps in physical education and the impact on teachers during the last six years. The development of mobile apps in physical education was grouped into four major themes: teaching and learning, training and health, measurement and assessment, and management and monitoring. There were several types of mobile apps used in each theme that successfully impacted teachers and students. In particular, the integration of mobile apps into physical education occurs in many ways but the dominant is in teaching and learning for this review compared to others. As current evidence shows many impacts of mobile app utilization on implementing physical education curriculum, teachers and students should find and use these mobile apps in their schools. Other than that, future investigations should focus on the design of mobile apps that are suitable for teachers and students in physical education related to content in each country.

ACKNOWLEDGEMENT

This research is generously funded by the Universiti Kebangsaan Malaysia under the Faculty of Education Research Grant (GG-2024-041)

REFERENCES

1. Abdulla, A., Whipp, P. R., McSporran, G., & Teo, T. (2022a). An interventional study with the Maldives generalist teachers in primary school physical education: An application of self-determination theory. *PLoS ONE*, *17*(5 May). https://doi.org/10.1371/journal.pone.0268098
2. Abdulla, A., Whipp, P. R., & Teo, T. (2022b). Teaching physical education in 'paradise': Activity levels, lesson context and barriers to quality implementation. *European Physical Education Review*, *28*(1), 225–243. https://doi.org/10.1177/1356336X211033696
3. Adams, A. J. (2023). *Effective Teaching Practices in Online Physical Education: The Relationship Between Video Feedback Guidance and Performance* (Doctoral dissertation, Middle Tennessee State University). https://www.proquest.com/docview/2851486241?pq-origsite=gscholar&fromopenview=true&sourcetype=Dissertations%20&%20Theses
4. Alvarez-Herrero, J. F., Martinez-Roig, R., & Urrea-Solano, M. (2022). Efficacy of food analysis applications in the redirection towards a healthy diet of university students. DOI: 10.47197/retos.v45i0.91376
5. Azevedo, A. B. C., Meninea, D. S., Magno, A. P., da Silva, T. M. V., Sousa, R. O., & Coswig, V. S. (2019). Aplicativo para dispositivos móveis é alternativa válida para medida de altura em saltos verticais em lutadores. *Revista Andaluza de Medicina del Deporte*, *12*(2). DOI: 10.33155/j.ramd.2019.01.007
6. Baek, S., Kim, G., & Park, H. W. (2020). A mobile delivered self-exercise program for female farmers. *Medicine*, *99*(52), e23624. DOI*:* 10.1097/MD.0000000000023624
7. Barber, W., Walters, W., Chartier, P., & Temertzoglou, C. (2022). Examining self-Confidence and self-Perceived competence in Canadian pre-service teachers (PSTs): the role of biographies in physical education teacher education (PETE). *Sport, Education and Society*, *27*(3), 347–360. https://doi.org/10.1080/13573322.2020.1844649
8. Ben, H., Wang, L., Ma, Z., & Yang, J. (2022). Design of college physical education curriculum based on mobile app development platform. *Wireless Communications and Mobile Computing*, *2022*(1), 9746549. https://doi.org/10.1155/2022/9746549
9. Beni, S., Fletcher, T., & Chróinín, D. N. (2021). Teachers' engagement with professional development to support implementation of meaningful physical education. *Journal of Teaching in Physical Education*, *41*(4), 570-579. https://doi.org/10.1123/jtpe.2021-0137
10. Böhm, B., Karwiese, S. D., Böhm, H., & Oberhoffer, R. (2019). Effects of Mobile Health Including Wearable Activity Trackers to Increase Physical Activity Outcomes Among Healthy Children and Adolescents: Systematic Review. *JMIR MHealth and UHealth*, *7*(4), e8298. https://doi.org/10.2196/mhealth.8298
11. Bogataj, Š., Pajek, M., Hadžić, V., Andrašić, S., Padulo, J., & Trajković, N. (2020). Validity, reliability, and usefulness of My Jump 2 App for measuring vertical jump in primary school children. *International journal of environmental research and public health*, *17*(10), 3708. https://doi.org/10.3390/ijerph17103708
12. Brickwood, K.-J., Watson, G., O'brien, J., & Williams, A. D. (2019). Consumer-based wearable activity trackers increase physical activity participation: Systematic review and meta-analysis. *JMIR MHealth and UHealth*, *7*(4). https://doi.org/10.2196/11819
13. Brown, J. M., Savaglio, R., Watson, G., Kaplansky, A., LeSage, A., Hughes, J., ... & Arcand, J. (2020). Optimizing child nutrition education with the

foodbot factory mobile health app: formative evaluation and analysis. *JMIR formative research*, *4*(4), e15534. Doi:10.2196/15534

14. Calderón, A., & Tannehill, D. (2021). Enacting a new curriculum models-based framework supported by digital technology within a learning community. *European physical education review*, *27*(3), 473-492. https://doi.org/10.1177/1356336X20962126
15. Chaichitwanidchakol, P., & Feungchan, W. (2020). Design and Implementation of Interactive Mobile Application for Autistic Children in Physical Education Class. *International Journal of Interactive Mobile Technologies*, *14*(14). https://doi.org/10.3991/ijim.v14i14.15477
16. Chen, J. (2024). Effective application of information technology in physical education teaching in the era of big data. Applied Mathematics and Nonlinear Sciences, 9(1). https://doi.org/10.2478/amns-2024-0642
17. Chen, Q. and Dong, M. (2022). Design of assessment judging model for physical education professional skills course based on convolutional neural network and few-shot learning. Computational Intelligence and Neuroscience, 2022, 1-11. https://doi.org/10.1155/2022/7548256
18. Cheng, C. H., & Chen, C. H. (2018). Developing a Mobile APP-Supported Learning System for Evaluating Health-Related Physical Fitness Achievements of Students. *Mobile Information Systems*, *2018*(1), 8960968. https://doi.org/10.1155/2018/8960968
19. Chiang, T. H. C., Yang, S. J., & Yin, C. (2019). Effect of gender differences on 3-on-3 basketball games taught in a mobile flipped classroom. *Interactive Learning Environments*, *27*(8), 1093-1105. https://doi.org/10.1080/10494820.2018.1495652
20. Cojocaru, A. M., Cojocaru, M., Jianu, A., Bucea-Manea-ţoniş, R., Păun, D. G., & Ivan, P. (2022). The Impact of Agile Management and Technology in Teaching and Practicing Physical Education and Sports. *Sustainability (Switzerland)*, *14*(3). https://doi.org/10.3390/su14031237
21. Díaz Barahona, J., Valverde Esteve, T., & Moya Mata, I. (2022). Estereotipos asociados al cuerpo humano: análisis de aplicaciones móviles usadas en la educación físico-deportiva. *Pixel-Bit*. https://doi.org/10.12795/pixelbit.90297
22. Gil-Espinosa, F. J., Merino-Marbán, R., & Mayorga-Vega, D. (2020). Endomondo smartphone app to promote physical activity in high school students | Aplicación móvil Endomondo para promocionar la actividad física en estudiantes de educación secundaria. *Cultura, Ciencia y Deporte*, *15*(46), 465–473. https://doi.org/10.12800/CCD.V15I46.1597
23. Grant, M. J., & Booth, A. (2009). A typology of reviews: an analysis of 14 review types and associated methodologies. *Health information & libraries journal*, *26*(2), 91-108. https://doi.org/10.1111/j.1471 1842.2009.00848.x.
24. Gusenbauer, M., & Haddaway, N. R. (2020). Which academic search systems are suitable for systematic reviews or meta-analyses? Evaluating retrieval qualities of Google Scholar, PubMed, and 26 other resources. *Research Synthesis Methods*, *11*(2), 181–217. https://doi.org/10.1002/jrsm.1378
25. Jastrow, F., Greve, S., Thumel, M., Diekhoff, H., & Süßenbach, J. (2022). Digital technology in physical education: a systematic review of research from 2009 to 2020. *German Journal of Exercise and Sport Research*, *52*(4), 504-528. https://doi.org/10.1007/s12662-022-00848-5
26. 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
27. Kemler, E., Romeijn, K., Vriend, I., & Huisstede, B. (2018). The relationship between the use of running applications and running-related injuries. *The Physician and sportsmedicine*, *46*(1), 73-77. https://doi.org/10.1080/00913847.2018.1412812
28. Khudhair, A., Ghazi, M., Ahmed, M., Kzar, M., Kzar, M., Alhsnawy, F., … & Hamza, D. (2024). Impact of digital competence on the teaching of sports education curricula in iraqi civil universities. Education Journal, 13(2), 77-82. https://doi.org/10.11648/j.edu.20241302.14
29. Kihara, S., Jess, M., McMillan, P., Osedo, K., Kubo, K., & Nakanishi, H. (2021). The potential of Lesson Study in primary physical education: Messages from a longitudinal study in Japan. *European Physical Education Review*, *27*(2), 223–239. https://doi.org/10.1177/1356336X20932950
30. Kim, Y., Lee, H., Lee, M. K., Lee, H., & Jang, H. (2020). Development of a living lab for a mobile-based health program for Korean-Chinese working women in South Korea: mixed methods study. *JMIR mHealth and uHealth*, *8*(1), e15359. doi: 10.2196/15359
31. Krippendorff, K. (2018). *Content analysis: An introduction to its methodology*. Sage publications.
32. Kyriakides, E., & Tsangaridou, N. (2017). *Primary Physical Education in Cyprus*. Routledge Handbook of Primary Physical Education.
33. Lee, A. S., Standage, M., Hagger, M. S., & Chan, D. K. (2021). Applying the trans-contextual model to promote sport injury prevention behaviors among secondary school students. *Scandinavian journal of medicine & science in sports*, *31*(9), 1840-1852. https://doi.org/10.1111/sms.14002
34. Lonsdale, C., Lester, A., Owen, K. B., White, R. L., Moyes, I., Peralta, L., ... & Lubans, D. R. (2015). An internet-supported physical activity intervention delivered in secondary schools located in low socio-economic status communities: study protocol for the activity and motivation in physical education (AMPED) cluster randomized controlled trial. *BMC Public Health*, *16*, 1-15. https://doi.org/10.1186/s12889-015-2583-7

35. Martín-Martín, A., Orduna-Malea, E., Thelwall, M., & Delgado López-Cózar, E. (2018). Google Scholar, Web of Science, and Scopus: A systematic comparison of citations in 252 subject categories. *Journal of Informetrics*, *12*(4), 1160–1177. https://doi.org/10.1016/J.JOI.2018.09.002
36. McEvilly, N. (2022). What is PE and who should teach it? Undergraduate PE students' views and experiences of the outsourcing of PE in the UK. *Sport, Education and Society*, *27*(6), 662–675. https://doi.org/10.1080/13573322.2021.1901684
37. Michalakis, V. I., Vaitis, M., & Klonari, A. (2020). The development of an educational outdoor adventure mobile app. *Education Sciences*, *10*(12), 382. https://doi.org/10.3390/educsci10120382
38. Milić, M., Radić Hozo, E., Maulini, C., De Giorgio, A., & Kuvačić, G. (2022). What Is the Place of Physical Education among the Teaching Priorities of Primary School Teachers? An Empirical Study on Importance, Qualification and Perceived Teachers' Competence. *Education Sciences*, *12*(9). https://doi.org/10.3390/educsci12090613
39. Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., Antes, G., Atkins, D., Barbour, V., Barrowman, N., Berlin, J. A., Clark, J., Clarke, M., Cook, D., D'Amico, R., Deeks, J. J., Devereaux, P. J., Dickersin, K., Egger, M., Ernst, E., Gøtzsche, P. C., … Tugwell, P. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. In *PLoS Medicine* (Vol. 6, Issue 7). Public Library of Science. https://doi.org/10.1371/journal.pmed.1000097
40. Ng, K., Klavina, A., Ferreira, J. P., Barrett, U., Pozeriene, J., & Reina, R. (2021). Teachers' preparedness to deliver remote adapted physical education from different European perspectives: Updates to the European Standards in Adapted Physical Activity. *European Journal of Special Needs Education*, *36*(1), 98-113. https://doi.org/10.1080/08856257.2021.1872848
41. Nuraini, S. (2024). Multimedia mobile application to improve the academic achievement of fifth grade elementary school students in physical education classes. Journal of Education Research and Evaluation, 8(1), 95-99. https://doi.org/10.23887/jere.v8i1.69862
42. Okoli, C. (2015). A guide to conducting a standalone systematic literature review. *Communications of the Association for Information Systems*, *37*(1), 879–910. https://doi.org/10.17705/1cais.03743
43. Oliveira, B. N. D., & Fraga, A. B. (2022). Cultura fitness digital no léxico da cultura corporal de movimento: temas emergentes para a educação física escolar. *Revista Brasileira de Ciências do Esporte*, *44*, e001922. DOI:10.1590/rbce.44.e001922
44. Papastergiou, M., Kanaros, D., Papamichou, A., & Vernadakis, N. (2021a). Effects of a project based on mobile applications, exergames and a web 2.0 social learning platform on students' physical activity and nutritional criteria in the era of COVID 19. *Educational Media International*, *58*(4), 297–316. https://doi.org/10.1080/09523987.2021.1989765
45. Papastergiou, M., Natsis, P., Vernadakis, N., & Antoniou, P. (2021b). Introducing tablets and a mobile fitness application into primary school physical education. *Education and Information Technologies*, *26*(1), 799–816. https://doi.org/10.1007/s10639-020-10289-y
46. Rezaee, R. (2024). Design and usability evaluation of a mobile application for self-care among iranian adolescents. BMC Public Health, 24(1). https://doi.org/10.1186/s12889-024-18341-z
47. Romero-Ramos, O., Fernández-Rodríguez, E., López-Fernández, I., Merino-Marbán, R., & Benítez-Porres, J. (2022). The Impact of the M-Learning Methodology on University Students. *Journal of Technology and Science Education*, *12*(1), 121–131. https://doi.org/10.3926/jotse.1442
48. Shmeleva, E. A., Kislyakov, P. A., Konstantinova, N. P., & Pchelinova, V. V. (2021). Digital technologies driven physical activity/education service in distance learning formats during covid-19 pandemic: Questionnaire survey. *Theory and practice of physical culture*, (6), 67-69. https://cyberleninka.ru/article/n/digital-technologies-driven-physical-activity-education-service-in-distance-learning-formats-during-covid-19-pandemic-questionnaire/pdf
49. Shutova, T. N., & Andryushchenko, L. B. (2020). Digitalization of physical education and sports educational process at university. *Theory and Practice of Physical Culture*, (9), 68-70. https://cyberleninka.ru/article/n/digitalization-of-physical-education-and-sports-educational-process-at-university
50. Shutova, T. N., Andryushchenko, L. B., Dreiko, N. Y., & Zvereva, S. N. (2022). Online calculator in diagnostics of functional state and body mass index. *Theory and Practice of Physical Culture*, (7), 41-44. https://cyberleninka.ru/article/n/online-calculator-in-diagnostics-of-functional-state-and-body-mass-index
51. Shutova, T. N., Andryushchenko, L. B., Orlan, I. V., & Ryzhkin, N. V. (2021). Digital approach to academic physical education and sports educational process. *Teoriya i Praktika Fizicheskoy Kultury*, *2021*(3), 12–14. https://cyberleninka.ru/article/n/digitalization-of-physical-education-and-sports-educational-process-at-university
52. Sierra-Correa, P. C., & Cantera Kintz, J. R. (2015). Ecosystem-based adaptation for improving coastal planning for sea-level rise: A systematic review for mangrove coasts. *Marine Policy*, *51*, 385–393. https://doi.org/10.1016/J.MARPOL.2014.09.013
53. Tolentino, J. C. G., Miranda, J. P. P., Punzalan, R. B., Manalang, J. C., Hermogenes, L. K. S., & Mallari, J. T. (2022). Towards the Development of a Mobile Application in Movement Competency Training Grounded on the User-Centered Design Model: The Case of a State University in the

Philippines. *Int. J. Interact. Mob. Technol.*, *16*(3), 92-103. https://doi.org/10.3991/ijim.v16i03.26447

54. Vega-Ramírez, L., Notario, R. O., & Ávalos-Ramos, M. A. (2020). The relevance of mobile applications in the learning of physical education. *Education Sciences*, *10*(11), 329. https://doi.org/10.3390/educsci10110329
55. Yon, K., & Saraç, L. (2022). Classroom Teachers' Practices of Physical Activity in 4th Grade Physical Education and Game Course. *Egitim ve Bilim*, *47*(211), 47–67. https://doi.org/10.15390/EB.2022.11438
56. Yu, H. (2020). *The Effects of Mobile App Technology on Technique and Game Performance in Physical Education* [Doctor of Education]. Arizona State University. https://keep.lib.asu.edu/system/files/c7/233808/Yu_asu_0010E_20168.pdf
57. Yu, G., & Fei, Q. (2022). Research on Sports Teaching App Based on Internet Statistical Data Analysis. In *International Conference on Signal and Information Processing, Networking and Computers* (pp. 813-821). Singapore: Springer Nature Singapore. https://doi.org/10.1007/978-981-19-4775-9_104
58. Yu, H., & Ha, T. (2021). The "APPropriate" Use of Technology for Assessment in Physical Education. *Journal of Physical Education, Recreation and Dance*, *92*(5), 58–61. https://doi.org/10.1080/07303084.2021.1899540
59. Yu, H., Kulinna, P. H., & Lorenz, K. A. (2018). An integration of mobile applications into physical education programs. *Strategies*, *31*(3), 13-19. https://doi.org/10.1080/08924562.2018.1442275
60. Zhou, J. (2023). A study on the reform strategy of college pe teaching mode in the new era. Education Journal, 6(7), 241. https://doi.org/10.31058/j.edu.2023.67031
61. Zulkifli, A. F., & Danis, A. (2021). Exploration of CoachEye application features to improve feedback during physical education. *Asian Journal of University Education (AJUE)*, *7*(2), 132-143. https://doi.org/10.24191/ajue.v17i2.13390
62. Zulkifli, A. F., & Danis, A. (2023). Unfolding The Barriers to Teaching and Learning with Technology Among Undergraduate Pre-Service Teachers. *Journal of Sustainability Science and Management*, *18*(6), 58-69. http://doi.org/10.46754/jssm.2023.06.005
63. Zvyagina, E. V., Petrushkina, N. P., & Latushin, Ya. V. (2021). Digitalization Of Self-Assessment in Athletes as An Integral Part of Athlete and Coach Performance During Lockdown. *Human Sport Medicine*, *21*, 61–68. https://doi.org/10.14529/hsm21s208