

Analysis of Android-Based Applications in Physical Education and Sports: Systematic Review

Análisis de Aplicaciones Basadas en Android en Educación Física y Deportes: Revisión Sistemática

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Abstract. Android-based applications have always experienced rapid progress and development over time. This development has an impact on various fields or scopes that exist around it. This study aims to comprehensively review the implementation of android applications in physical education and sports. This study used a systematic review method by following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). A total of 331 articles from the SCOPUS database were screened to determine 10 relevant articles. These articles were then subjected to a systematic review. The results of the systematic review presented the research that has been conducted covering several fields, such as learning media, training, health, and sport biomechanics. The presentation of research data from the review results contributed to the development of research in the field of Android-based applications in physical education and sports. On the other hand, research related to Android-based applications needs to be done intensely in physical education.

Keywords: technological development, physical activity, literature review, performance analysis.

Resumen. Las aplicaciones basadas en Android siempre han experimentado un rápido progreso y desarrollo a lo largo del tiempo. Este desarrollo repercute en diversos campos o ámbitos que existen a su alrededor. Este estudio pretende revisar de forma exhaustiva la implementación de aplicaciones android en la educación física y el deporte. Este estudio utilizó un método de revisión sistemática siguiendo las Elementos de Información Preferidos para Revisiones Sistemáticas y Metaanálisis (PRISMA). Se examinaron un total de 331 artículos de la base de datos SCOPUS para determinar 10 artículos relevantes. A continuación, estos artículos se sometieron a una revisión sistemática. Los resultados de la revisión sistemática presentaron las investigaciones realizadas en diversos campos, como los medios de aprendizaje, el entrenamiento, la salud y la biomecánica deportiva. La presentación de los datos de la investigación a partir de los resultados de la revisión contribuyó al desarrollo de la investigación en el campo de las aplicaciones basadas en Android en la educación física y el deporte. Por otra parte, la investigación relacionada con las aplicaciones basadas en Android debe realizarse intensamente en la educación física.

Palabras clave: desarrollo tecnológico, actividad física, revisión bibliográfica, análisis del rendimiento.

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Introduction

In the current digital era, smartphone technology has become part of various aspects of life, including in the field of education (Hemalatha et al., 2024). Android is a smartphone technology that has shown a significant increase in the number of users (Alexandre, Ouni, Saied, Bouktif, & Mkaouer, 2022). Statistical data shows that active Android users reach billions worldwide (Alkindi, Sarrab, & Alzeidi, 2021). The relative affordable cost of the development of Android applications, provide many opportunities to address specific needs in the field of physical education and sports (Zhang, Tian, & Li, 2020).

The development of wider accessibility of Android applications for smartphone users can be used to enrich the learning experience of students (Adrizaral & Pahlifi, 2020) and athletes (Mou & Yang, 2021). Learning applications are used to create a more attractive learning atmosphere in educational institutions (Johansyah Lubis et al., 2022). Attractive learning makes it easier for students to understand the material comprehensively (Shangguan, Wang, Gong, Guo, & Xu, 2020). On the other hand, Android applications in the coaching sector are also often developed from year to year (Yan et al., 2022). The use of Android applications is centered on the support for performance analysis (Bortolan et al., 2023). This is closely related to sports biomechanics, which aims to review the effectiveness of the techniques of

athletes (Rusdiana et al., 2021). The app results are then used as a reference for the preparation of training programs (Qureshi et al., 2023).

The role of Android in the fields of education and training, has a significant impact on developments in these two fields (Cirilo, Rivera, & Mauricio, 2021; Liu & Yang, 2014). Modern learning with the development of the digital era is very appropriate and effective in the 21st century (Zeng, 2022). The athlete's training and condition, contribute to increasing the achievements obtained (Hou & Tian, 2022). Maximum use of Android-based technology has made these developments more significant (Ming, 2018; Stepanov, Cherepanov, Ilinykh, & Nenashev, 2023).

This review was carried out by looking at various existing studies to assess the potential, benefits and challenges in implementing Android applications in physical education and sports. This overview tries to understand how technological innovations in education can be integrated into existing curricula and teaching practices. The integration that occurs in the world of sports will also be reviewed through collaboration in technological developments in sports.

This literature review is not only important for educational practitioners and sports coaches, but also for application developers and researchers in the field of educational technology. The use of Android-based applications in physical education and sports opens up new possibilities in learning. Apart from that, it also provides a platform that can

increase engagement and training effectiveness. This systematic review research aims to comprehensively examine the application of Android applications in the context of physical education and sports with the following research questions: a) examine research works in the use of Android apps in the field of physical education and sports; b) extract the ten most relevant studies; and c) comparatively appraise the research tendencies in these studies

Method

In this study, the method used was a systematic review. Article searches were carried out with a comprehensive strategy in the SCOPUS research journal database. Keywords used include “Android” AND “Physical Education” AND “Sport”. The inclusion criteria reviewed for this research were journals in the last five years starting from 2024 that were Scopus accredited. In total, 142 articles from journal databases were identified. There were 10 eligible articles selected for this systematic review. For standard operationalization, this study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Guidelines (Figure 1).

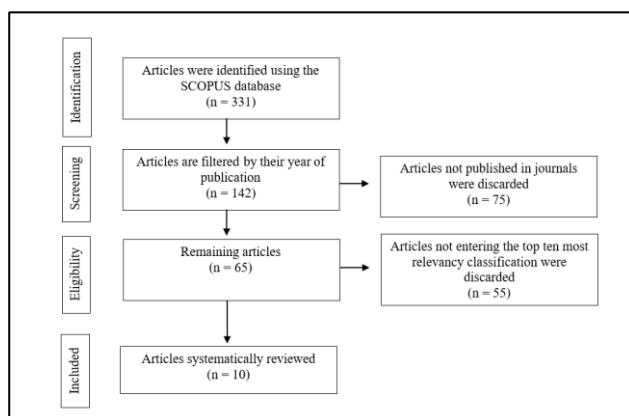


Figure 1. PRISMA flowchart of the article selection process

Results

The research results presented are based on a systematic review conducted through the SCOPUS database. Research trends were analyzed using VosViewer software, aiming to find relationships and connections from previous research related to the topic under study.

Research trends of android in physical education

The Android research trend in physical education began in 2018 (Figure 2). In 2018, research focused only on studies or research developments in the Android field. Then, in 2020-2023 research began to develop into an application that is used as a medium in the physical education learning process.

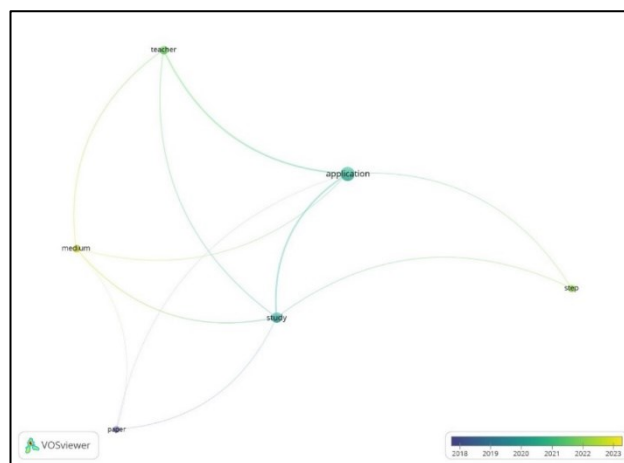


Figure 2. Research trends of Android in physical education

Keywords trend of android in physical education

Trends in keywords from Android research in physical education show the lack of Android research in the field of physical education (Figure 3). The connections shown by keyword trends do not represent a very close relationship between the keywords. Based on the color displayed, this keyword trend is divided into 3 clusters. The keywords “medium”, “study”, and “paper” are grouped as one large cluster in this trend. This proves that Android research in physical education focuses on experimentation and using Android as a medium. “Teacher” and “application” are grouped into one cluster, proving the importance of implementing Android-based applications in learning. The keyword “step” indicates that the research conducted focuses on developing applications for sports software such as smartwatches.

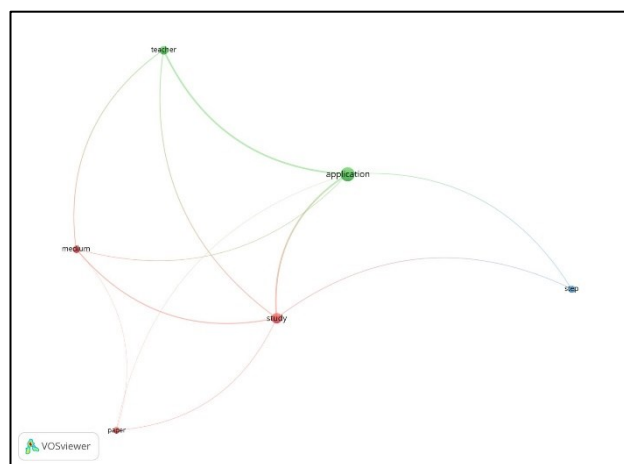


Figure 3. Keywords trend of Android in physical education

Research trends of android in sport

Since 2016, Android research in sports has begun to be carried out and developed (Figure 4). In that year, research focused on specific or technical developments in Android. Then, through 2017-18, research transformed into the application of Android applications to various fields, for example in work and computers. Apart from that, the benefits of implementing Android also began to be explored

through research that year. Entering 2019, research shifted focus to the fields of sports and health. The use of Android in exercising and improving fitness began to be developed through research in that year.

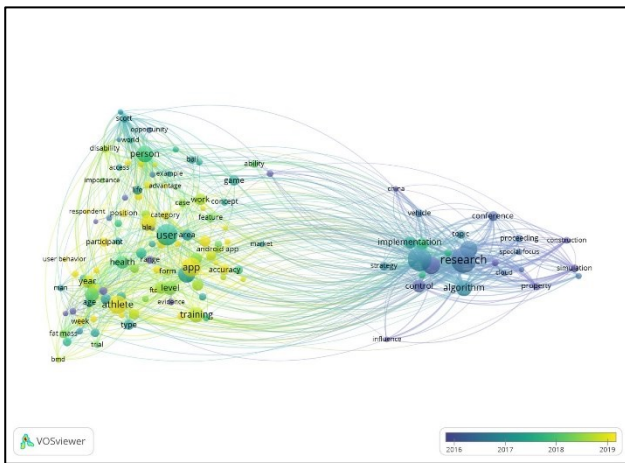


Figure 4. Research trends of Android in sport

Keywords trend of android in sport

Keyword trends shown by Android research in the sports sector present three clusters based on the color displayed (Figure 5). Keywords such as “athlete”, “app”, and “exercise” are grouped into one large cluster. In this case, the cluster proves that research trends to focus on the development of Android applications for coaching. Moving on to the next cluster, the keywords are still related to the previous one: "advantage", "person", and "opportunity". This proves that the research was carried out to determine the importance of the benefits resulting from research developments in the field of Android in sports. These two large clusters are interrelated, providing feedback to each other

from the research conducted. On the other hand, there is research that is relevant but has a relationship that is not very significant. These statements are marked with the keywords "research", "implementation", and "algorithm" in the third cluster. In this cluster, research focuses more on the development and use of Android as a part of technological development. The research carried out focuses more on the mechanisms and technicalities of Android operation.

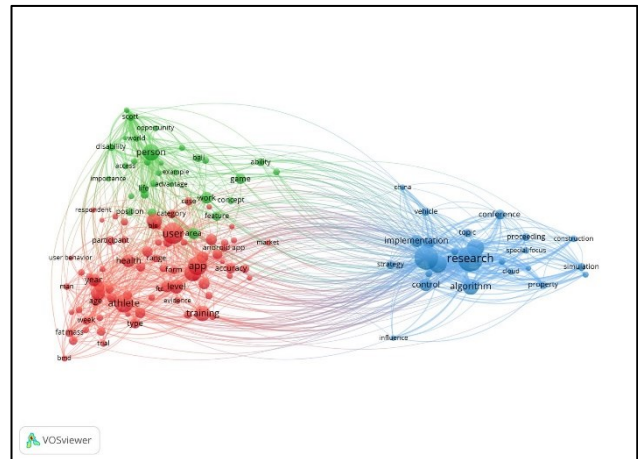


Figure 5. Keywords trend of Android in sport

Top ten articles relevant for android apps supporting physical education and sport

The literature review conducted for 10 relevant articles is presented in the following table (Table 1). Results the review shows that the research focuses on several themes. These themes are learning media in physical education, sports biomechanics and coaching, and Android-based applications for sports and health.

Table 1. Articles relevance of Android in physical education and sport

Author	Research purposes	Sample Characteristics	Study Design	Results
(Santoso et al., 2023)	Develop more appropriate, effective, and efficient application software for physical education.	The studies were conducted through small and controlled sample group studies and large sample group studies or product marketing studies.	Research and Development	There were various conclusions, including that Android-based tools could be one of the teacher's solutions in helping to collect students' skills related to physical fitness, with Android the teacher's tasks can be performed quickly, effectively and efficiently.
(Sri Gusti Handayani, Myori, Yulifri, Komaini, & Mario, 2023)	The purpose of this study is to develop Android-based gymnastics learning media to improve the handstand skills of junior high school students.	A total of 47 junior high school students with 26 males and 21 females were involved in the study.	Research and Development Plomp Model	The objective is to create a product in the form of Android-based gymnastics learning media to enhance handstand skills in junior high school students.
(Johansyah Lubis et al., 2022)	To assess the efficacy of problem-based learning and the flipped classroom model, when combined with an Android application based on biomechanical analysis, in improving the learning outcomes of pencak silat. The study focused on teaching students the movement of a single artistic category of pencak silat.	The research involved 76 physical education students from Islamic University 45 Bekasi in Indonesia (mean age = 20.51 years, standard deviation = 0.49 years; 59 males and 17 females).	Experimental Study	This learning design may be an effective approach to enhancing student learning outcomes in pencak silat. By employing problem-based learning models in the learning process, students can more effectively grasp the material.
(Xu, 2024)	The objective of this research is to develop a lightweight motion cap-	-	Experimental Study	The light motion capture device developed in this study has achieved satisfactory results in the field of identification systems. The

Table 1.
Articles relevance of Android in physical education and sport

Author	Research purposes	Sample Characteristics	Study Design	Results
	ture device based on the Android intelligent platform and to apply it to the sports field auxiliary recognition system.			device exhibits high accuracy and low delay, enabling the accurate identification and tracking of the body position and movement trajectory.
(Perdana et al., 2021)	The objective of this application is to facilitate the discovery of information about physical activities in the Yogyakarta area and its surrounding regions.	The preliminary study utilized a sample size of 50 respondents, whereas the subsequent study utilized a larger sample size of 100 respondents.	Research and Development	The results of the small-scale and large-scale testing indicated that the majority of respondents perceived the development of the present application for sports enthusiasts as beneficial and necessary.
(Hidayah et al., 2024)	To examine the requirements of athletes and trainers regarding the monitoring of training program implementation on Android-based devices.	The study included 20 athletes, five licensed trainers in petanque sports, and one expert in the fields of physical conditioning, information, and technology.	Descriptive Quantitative	It is evident that athletes require the implementation of a monitoring system to enhance their performance. Petanque trainers, in particular, would benefit from the incorporation of technology-based Android applications to facilitate the monitoring of training programs and activities outside of the athlete's training regimen.
(Purwanto, Mentara, & Marhadi, 2023)	The objective of this research is to develop an e-sports massage application based on an Android app, using the ADDIE design methodology, with the intention of establishing its efficacy as a learning medium for students.	The study involved 36 research participants from two distinct campuses.	Research and Development ADDIE Model	The e-sport massage application has been demonstrated to enhance the practical skills of students by 80%. Furthermore, the acceptability of e-sport massage applications among students is 90%, indicating that this application can be effectively integrated into the curriculum.
(Nurkadri et al., 2023)	This research project examines the general preparatory physical exercise program for Volta Club tennis players and students, using the Android platform.	-	Research and Development Borg and Gall Model	The results of the validation of the two experts indicate that the exercise development research can be applied to trainers engaged in activities such as playing tennis.
(Cuesta-Morales et al., 2022)	The introduction of the Varse app for Android mobile devices represents a significant advancement in the field of heart rate variability (HRV) analysis. The app is capable of acquiring and labeling heart rate (HR) signals in real-time, offering a comprehensive solution for the acquisition and analysis of HRV data.	-	Developing an Android-based device VARSE	VARSE is a comprehensive software tool that can be readily downloaded or installed on Android mobile devices. It is suitable for use by anyone who wishes to record heart rate (HR) signals while performing different activities, as well as by members of the medical scientific community who require the ability to perform real-time heart rate variability (HRV) analyses.
(Sri Gusti Handayani, Myori, Yulifri, Zakaria, et al., 2023)	The objective of this study is to examine the impact of using Android-based gymnastics learning media on the acquisition of cartwheel skills among junior high school students.	The participants were male students in their seventh and eighth grades, enrolled in combined physical education classes, and aged 12 to 13 years.	Experimental Study	The use of this learning media has the potential to enhance the cartwheel skills of junior high school students. It is therefore anticipated that this approach could facilitate the overcoming of limitations in gymnastics learning, whether employed by PE teachers, junior high school students, or gymnastics practitioners.

Learning media in physical education

Physical education is a type of learning that requires multimedia in the learning process (Jastrow, Greve, Thumel, Diekhoff, & Süßenbach, 2022). The learning media used are very varied. Nowadays, Android-based applications have begun to be used in the physical learning process. The use of Android-based applications provides students with innovative learning experiences.

Sports biomechanics and training

Currently, the use of Android-based applications in sports biomechanics has been intensively carried out (De Froda, Thigpen, & Kriz, 2016). The efficient application model, using only an Android smartphone, makes implementing this application suitable for various conditions. The

application plays a role in analyzing performance and provides a comprehensive understanding to athletes and coaches. The results of this analysis will be used as an evaluation and preparation of training programs for the coming period.

Android-based application for sports and health

The development of Android-based applications occurs very quickly and is unpredictable. Nowadays, many Android applications have been developed as a means of exercising (Wuttidittachotti, Robmeechai, & Daengsi, 2015). These developments are very diverse, starting from running applications, applications for finding special exercise venues, weight training applications, and many more. The impact is that it makes it easier for users to carry out sports

activities anywhere and anytime. Apart from that, in the health sector, the development of this application is in the form of a tool for measuring HR, oxygen in the blood, stress levels, BMI/BMI, and so on (Beukenhorst et al., 2019).

Discussion

Technological developments that have occurred in recent years have progressed very rapidly (Z. Wang, 2022). The development that was most felt and had a big impact was Android (de Morais et al., 2022; Khoumeri, Cheggou, & Ferhah, 2019). Present time, Android has a big role in daily work in various fields (Munkhtsetseg & Seo, 2022). Android's role in facilitating society is through applications developed based on Android itself (Rudin, Audah, Jamil, & Abdullah, 2016). One area that uses Android applications as supporting media is sports. The use of Android applications in the sports sector does not focus only on physical activity or coaching. The use of Android applications also extends to the world of education, namely physical education (S G Handayani et al., 2023).

Research related to Android-based applications in the field of physical education and sports began in 2016. The data presented by the result of a systematic review using the SCOPUS database. Based on the results of the systematic review, it is divided into two variables, namely physical education and the second variable is sport. In 2016-2017, research developments in sports focused on the technical and operational development of Android applications. Android-based applications have several features that must be developed and maintained periodically (Oliveira, Borges, Silva, Cacho, & Castor, 2018). The components in an Android application have specifications and uniqueness according to their use in the application (El-Zawawy, Faruki, & Conti, 2022). The preparation of detailed and complex algorithms makes this Android application a modern and practical medium (Philiyanti, Haristiani, Rasyid, & Emzir, 2019). The application also has storage for user data (Singh, Carminati, & Ferrari, 2021). Periodic quality improvements need to be carried out, considering the large number of components in Android-based applications (Shah, Aurelio, Frasquilho, & Fradgley, 2021).

Entering 2018 – now, the development of Android-based applications is starting to enter the world of physical education and sports. In physical education, Android-based applications are starting to be developed as learning media by physical education teachers (Santoso, Rahayu, Sugiharto, & Setyawati, 2023). Use of learning media based on an Android application, adapting to technological developments occurring in the 21st century (Botagariyev et al., 2024). This learning media has a significant impact on improving student learning outcomes (J Lubis et al., 2022). It becomes easier for students to understand and learn something with attractive audio-visual stimuli (Zuliana, Oktavianti, Ratnasari, & Bintoro, 2020). Comprehensive understanding provided through an Android-based application, creates

a modern and up-to-date learning feel (Huang, Chen, & Chou, 2016).

The development of Android-based applications has spread widely to the world of sports (Perdana, Widiyanto, & Ilham, 2021). The developments that occur are in the form of wearable devices (Khatun et al., 2022), performance analysis applications (Hummel, Fehr, & Ferger, 2013), sports training applications (Ni & Mao, 2021), and others. Smartwatches are one of the devices that are widely used for exercising by connecting via an application on Android (Harrison et al., 2023). The measurements that can be taken by this device are very complex, starting from footsteps (Schmidt, Wille, Rheinländer, Wehn, & Jaitner, 2018), calories burned (Xie et al., 2018), oxygen levels (Putra, Suarmin, & Ekariani, 2022), heart rate (Ichwana, Ikhlas, & Ekariani, 2018), to estimating exercise intensity and volume (Adamakis, 2020). Devices like this contribute to athletes and other sportspeople. The performance analysis features that can be provided by Android-based applications can bring changes to the world of coaching (Rana & Mittal, 2019). The training process becomes more focused and organized through the results of the analysis which are used as evaluation material (P. Wang, 2023).

The development of Android-based applications in the world of sports has had a significant impact on the fitness of its users (Mohamed Ariff, Roslan, Salleh, & Mohamad, 2021). This application can determine exercise programs that require fitness and adjust to the intensity of the user's physical activity (Semsem & Martin, 2022). Preparing diet patterns and fulfilling nutritional intake can also be provided and educated via an Android-based application (K. Wang et al., 2023). The development of complex Android-based applications in the world of sports provides a positive experience for its users (Hidayat, Syahri, Afdlol, & Zahiro, 2024).

Conclusion

The research trend for Android-based applications in physical education and sports experiences continuous development from year to year. Development is carried out in stages starting from application production to application refinement and is ready to be integrated into various fields. Physical education and sports are two of the various fields affected by the development of Android-based applications. The differentiation of the learning process from traditional to modern is a form of development of this application in physical education. A more organized and structured training method is the impact that this application has in the field of sports coaching. Physical activity that is practical and effective, can be done by anyone, anywhere, and at any time is the result of the development of Android-based applications in sports. Health and fitness are additional positive points that the development of this application can provide in physical education and sports.

Based on the systematic review carried out, the research trend in physical education is more directed toward the

study or research of Android-based applications. Then, the research developed until an Android-based application was used as a medium for transferring knowledge to students by physical education teachers. Meanwhile, the trend in the world of sports is more towards Android-based applications technically and operationally. Furthermore, this application began to be applied in the world of sports, both in training and physical activities carried out by athletes. The benefits and impacts of this implementation are the subject of further research into this trend.

The systematic review carried out in this study was limited in the number of articles reviewed. This research only conducted a systematic review of articles sourced from the SCOPUS database. In future research, expansion of the database can be carried out to determine research trends in Android-based applications in physical education and sports.

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