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Effect of smartphone applications before deep learning: promoting physical activity enjoyment and physical fitness among children with disabilities

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ABSTRACT

Background: The use of smartphone applications (SA) before deep learning (DL) is currently showing an increase in popularity in the context of physical education (PE) teaching, but the effects smartphone applications within deep learning (SADL) on physical activity enjoyment (PAE) and physical fitness (PF) are still unclear. **Objectives:** Our current study aims to analyse the effects of SADL on PAE and PF among students with disabilities. **Methods:** This study adopted an experimental design with a 10-week pretest-posttest design. We involved 40 participants with disabilities from two schools in Karawang (Indonesia). They were allocated to the SADL (n = 20) and control group (CG, n = 20). PAE and PF assessments were conducted twice, at the pretest and posttest stages. **Results:** Our main findings prove that there was no difference in PAE and PF scores between the SADL and CG at the pretest stage, but we found different results at the posttest stage, which showed that there was a difference in PAE and PF scores between the SADL and CG. **Conclusion:** The findings suggest that integrating smartphone applications within a deep learning framework may enhance physical activity enjoyment and selected components of physical fitness among students with disabilities.

Keywords: Two types of teaching; physical activity enjoyment; physical fitness, students with disabilities

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Authors' Contribution: a – Study Design; b – Data Collection; c – Statistical Analysis; d – Manuscript Preparation; e – Funds Collection

INTRODUCTION

Physical education (PE) teachers in the current era have tried to innovate and change the paradigm so that they do not always rely on traditional teaching (Sucipto et al., 2023). This is because traditional teaching has not shown satisfactory results in improving the potential of some students, including students with disabilities. PE for students with disabilities is not only about teaching a particular sport but also about creating a learning environment that is much more interesting and effective for them (Bertills & Björk, 2024). The literature shows that some of the needs that must be developed in students with disabilities are physical activity enjoyment (PAE) and physical fitness (PF).

In theory, PAE can be defined as a feeling of pleasure, enjoyment, happiness, or satisfaction during any type of physical activity (De Souza-Pajuelo et al., 2021). PAE is an important factor that must be achieved when carrying out an activity, including sports in PE classes (Bajamal et al., 2024). Basically, students with disabilities have the same rights as normal students in PE teaching, where teachers must pay attention to, nurture, and increase the enjoyment of physical activity. In the context of students with disabilities, PAE can be a parameter for the success of learning programmes that have been implemented by teachers (Amalia et al., 2021). In addition, high PAE has significant benefits for the health of both normal students and students with disabilities (Alecu et al., 2025). Meanwhile, students with disabilities who are not enthusiastic and less active in physical activities can trigger several diseases such as obesity, cancer, diabetes, and heart disease (Berki & Tarjányi, 2022). Meanwhile, other data show that students with disabilities who are inactive in physical activities have low PF levels (Ha et al., 2024). An expert has explained that the enjoyment of physical activity must be presented to students with disabilities from an early age, because children and adolescents today tend to be distracted by modern technology such as smartphones or tablets (Martín-Rodríguez & Madrigal-Cerezo, 2025). On the other hand, regularly increasing PAE plays an important role in improving cognitive and mental functions as well as academic achievement (Demetriou et al., 2020).

PF is another aspect that is equally important for students with disabilities to undergo the PE learning process at school (Silva et al., 2024). Basically, PF is the biomotor ability to support optimal movement; for example, high physical fitness can result in longer endurance without experiencing fatigue when undergoing the PE learning process at school. Conversely, low PF will have an impact on significant fatigue in students and ultimately cause them to be lazy and unenthusiastic (Redondo-Flórez et al., 2022). Furthermore, it is known that PF is closely related to other motor skills such as running, jumping, throwing, and kicking and PF even correlates positively with students' health levels (Pelemiš et al., 2024). A previous study found that nearly 90% of students in schools often do not participate in sports activities, and one of the contributing factors is low PF levels (Sun et al., 2024).

Given the importance of PAE and PF among students with disabilities, it is necessary to explore and improve them through learning that is interesting and meaningful for them. Currently, there is an innovation in PE teaching that integrates media technology. With the availability of media technology, it is hoped that it will not only have a negative impact but also provide positive benefits for everyone (Yang et al., 2024). Media technology can be an important solution that teachers can consider so that they can create a learning process that is much more interesting and less monotonous for students with disabilities. Some media that have been used in the documented PE teaching process include augmented reality (Liang et al., 2023), virtual reality (Pérez-Muñoz et al., 2024), and video modelling (Tannoubi et al., 2023). Smartphone application (SA) media technology is currently experiencing an increase in popularity (Bonn et al., 2024), and has become a trend for researchers around the world. According to a literature review, the main benefit of involving SA in learning is that it provides flexibility, allowing students with disabilities to exercise anytime and anywhere with the guidance of SA (Vega-Ramírez et al., 2020). Several previous studies have shown scientific evidence and results that SA has the potential to be effective in significantly increasing physical activity (Gil-Espinosa et al., 2022; Wibowo et al., 2020). In addition, another systematic review shows that the use of mobile health applications has been proved to increase physical activity levels and reduce sedentary behaviour (Zhang, Wang et al., 2022). The use of SA will be much more optimal if it is integrated into teaching, including deep learning (DL).

Conceptually, DL is a learning approach that focuses on deeper and more meaningful understanding related to sports in PE classes (Li, 2025). With the integration of smartphone applications during DL, this will be an important innovation in PE learning and has the potential to create a learning climate that is far more interesting, new, and meaningful (Wu & Liu, 2022). Previous studies have shown that the use of smartphone apps during PE classes can increase student engagement and game performance (Rahayu et al., 2025). By implementing DL, students with disabilities will be able to study each PE teaching material more deeply, thus increasing their chances of achieving much better results. This is also explained by Zhu et al. (2023) that applying music during DL has the advantage of improving physical quality, motor skills, and independence in learning.

Thus, although DL has been researched and proven to have benefits for students, research reporting on the effects of SA within DL (SADL) on PAE and PF among students with disabilities is still inadequate. The combination of SADL needs to be carried out so that this can become an important innovation in a PE teaching curriculum in schools which is ultimately expected to result in the achievement of learning objectives that are much more optimal than traditional teaching.

Our current study aims to analyse the effects of the SADL programme on PAE and PF among students with disabilities, which are still unclear. Therefore, in this context, we hypothesise that the SADL program will have a significantly higher effect than the control group (CG) on efforts to improve PAE and PF.

METHOD

Design

Our current research involved an experimental pretest-posttest design to measure the effects of SADL on PAE and PF. The study was conducted over 10 weeks, with three sessions per week, scheduled on Mondays, Wednesdays, and Saturdays. The study design is shown in **Figure 1**.

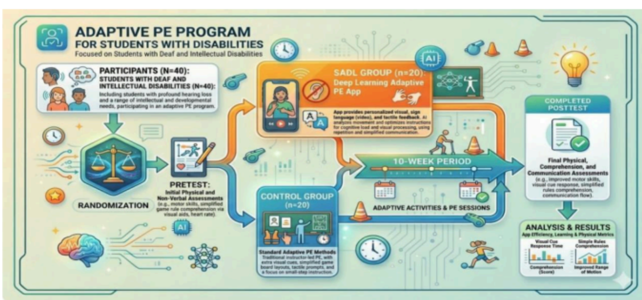

Figure 1. Experimental Design Flow. Note: SADL: Smartphone Applications Deep Learning; CG = Control Group

Participants

We used the Düsseldorf G-Power analysis (v 3.1.9.7) to determine the minimum sample (participants) requirement. The analysis used a 0.05 power (1-β 0.80) and an effect size (0.25). The results indicate that at least 30 participants should participate in this study (Kurtoğlu et al., 2025). Based on the results of the G-Power analysis, 40 students (20 males and 20 females) were recruited to participate in this experimental study.

The participants involved were students with disabilities from two schools in the city of Karawang. They were recruited randomly to represent the participants in this study's inclusion criteria: (i) students with disabilities (deaf and Intellectual), (ii) parental consent to participate. Students who met the inclusion criteria were excluded. Ethical approval for this study was obtained from the Research Ethics Committee of Universitas Singaperbangsa Karawang (345-UNSIKA/24/10/2025). All activities in this study were in accordance with the Declaration of Helsinki criteria.

Table 1. Demographic Characteristics of Participants

Characteristic	SADL Group (n=20)	CG (n=20)
Age (years)	9.90±1.45	9.80±1.39
Gender:		
Male	11 (55%)	11 (55%)
Female	9 (45%)	9 (45%)
Disability type:		
Deaf	12 (60%)	12 (60%)
Intellectual	8 (40%)	8 (40%)
Body mass index (kg/m^2)	18.65 ± 2.12	18.42 ± 2.08

Notes: SADL: Smartphone Applications Deep Learning; CG = Control Group.

Instruments

Physical Activity Enjoyment

Based on a previous study to assess the extent to which students enjoy physical activity, the Physical Activity Enjoyment Scale (PACES) can be used (Ha et al., 2024). PACES consists of 16 statements, for example: "I am always physically active in PE class." Participants can use a Likert scale from 1 (indicating that the student strongly disagrees) to 5 (indicating that the student strongly agrees). Students fill out the PACES using iPads during PE class, and the research team provides assistance, such as reading the statements aloud for students with disabilities who have difficulty understanding the questions. The PACES is known to have a Cronbach's alpha (0.906).

Physical Fitness

In this study, we used two types of tests to assess the physical fitness of students with disabilities. The first test was the push-up, where participants were instructed to get into a push-up position and, after the instruction "Go," perform push-ups for 1 minute. The second test was *the sit & reach* (Bogalho et al., 2022), where participants were instructed to push a ruler forward as far as possible.

Experimental Procedure

The SADL programme was implemented from October to November 2025, or for 10 weeks, on-site at Universitas Singaperbangsa Karawang (Indonesia). In the first week, we collected information about the demographic characteristics of the participants and continued with participants doing a 5-minute warm-up. All participants carried out a pretest, which was a measurement of PAE and PF for 60 minutes, and the activity ended with a 5-minute cool-down. In the second to ninth weeks, the SADL and CG programmes each lasted for 60 minutes and were carried out separately, with SADL on field A and CG on field B. Then in the tenth week, all participants carried out a posttest, which was a re-measurement of aspects of PAE and PF with the same rules and duration as the pretest stage.

SADL Programme

The SADL programme was conducted during PE class from 8:00 to 9:00 a.m. at the Singaperbangsa Karawang University (Indonesia) field. First, participants (students with disabilities) were instructed to carry out the SADL programme, which consisted of three phases. The first phase is warm-up (5 min), followed by analysing the lesson material through SA and demonstrated by the teacher. In the second phase, participants learn in groups, with each group consisting of 5 participants performing game-based physical activities. The third phase was evaluation, where the teacher and participants evaluated the learning outcomes that had been carried out previously and ended with a cool-down. For more details about the 10-week SADL programme, see **Table 2**.

Table 2. 10-week SADL programme

Weeks	Learning Activities		
1	Phase 1	Phase II	Phase III
	Pretest		
2-3	• Warm-up (5 min) • Analyse lesson material through SA and demonstration by the teacher (5 min).	• Learn in groups to carry out game-based physical activities, such as throwing and catching balls, throwing balls at targets, building towers (40 min).	• Evaluate learning outcomes (5 min). • Cool-down (5 min).
4-5	• Warm-up (5 min) • Analysing lesson material through SA and demonstrated by the teacher (10 min).	• Group learning to carry out game-based physical activities, such as soccer (40 min).	• Evaluate learning outcomes (5 min). • Cool-down (5 min).
6-7	• Warm-up (5 min) • Analysing lesson material through SA and demonstrated by the teacher (10 min).	• Group learning to carry out game-based physical activities, such as futsal (40 min).	• Learning outcome evaluation (5 min). • Cool-down (5 min).
8-9	• Warm-up (5 min) • Analyse lesson material through SA and demonstrated by the teacher (10 min).	• Group learning to carry out game-based physical activities, such as putting balls in a basket, jumping over cardboard boxes, bocce (40 min).	• Evaluate learning outcomes (5 min). • Cool-down (5 min).
10	Posttest		

CG Programme

The CG programme in this study only used traditional teaching methods without the use of modern technology or special learning models. The duration of the CG learning activity was 60 minutes, consisting of (i) warm-up (5 min), (ii) learning activities (50 min), and (iii) evaluation and cool-down (5 min).

Data Analysis

In our current study, we used Jamovi v 23.28 to analyse all data. First, we performed descriptive statistical tests, including mean and standard deviation. In addition, we tested normality and homogeneity, and the results showed that PAE and PF data were normally distributed and homogeneously varied ($p > 0.05$). We used an independent sample t-test to analyse the differences in PAE and PF scores between SADL and CG in the pretest and posttest stages. We chose a criterion of $p < 0.05$ to determine significance.

RESULTS AND DISCUSSION

Results

The Effectiveness of SADL and CG on PAE

Table 3 shows that there was no difference in PAE scores between SADL and CG in the pretest phase (p > 0.05), but we observed a difference in PAE scores between SADL and CG in the posttest phase.

Table 3. PAE Scores in Both Groups

Measurement Time	SADL Groups Mean±Standard Deviation	CG Mean±Standard Deviation	*p*
Pretest	45.2 ± 6.8	44.8 ± 7.1	0.851
Posttest	63.7 ± 5.4	47.8 ± 6.9	<0.001

Notes: SADL: Smartphone Applications Deep Learning; CG = Control Group; PAE = Physical Activity Enjoyment.

The Effectiveness of SADL and CG on PF

Table 4 shows that there was no difference in PF scores between SADL and CG in the pretest stage ($p > 0.05$), but we observed a significant difference in PF scores between SADL and CG in the posttest stage.

Table 4. Test of PF Score in Both Groups

Component	Time	SADL Groups Mean±Standard Deviation	CG Mean±Standard Deviation	*p*
Push-up	Pretest	8.6 ± 2.1	8.4 ± 2.3	0.213
(reps)	Posttest	14.3 ± 2.8	9.7 ± 2.5	<0.001
Sit & Reach	Pre-test	18.2 ± 4.6	17.9 ± 4.8	0.134
(cm)	Posttest	23.7 ± 3.9	19.1 ± 4.8	<0.001

Notes: SADL: Smartphone Applications Deep Learning; CG = Control Group; PF = physical fitness.

In addition, both groups showed significant improvements from pretest to posttest. However, the magnitude of improvement in PAE and PF scores was greater in the SADL group than in the CG (see **Figures 2** and **3**).

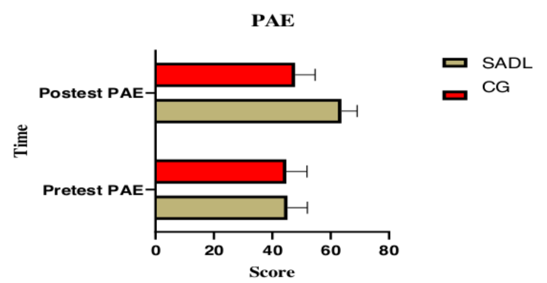

Figure 2. Changes in PAE scores at the pretest and posttest stages between the two teaching groups.
Notes: SADL: Smartphone Applications Deep Learning; CG = Control Group; PAE: Physical Activity Enjoyment.

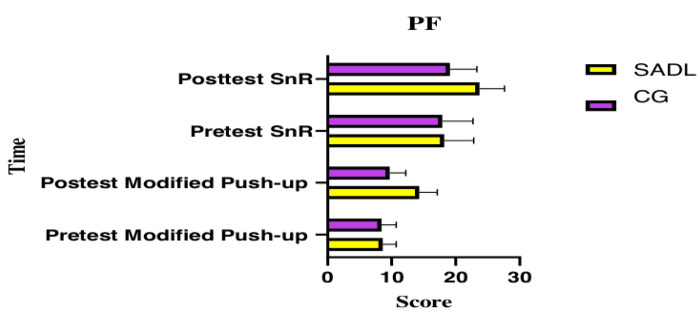

Figure 3. Changes in PF scores at the pretest and posttest stages between the two teaching groups.
Notes: SADL: Smartphone Applications Deep Learning; CG = Control Group; PAE: Physical Activity Enjoyment; PF = Physical Fitness; SnR = Sit and Reach.

Discussion

SADL programme compared to CG on PAE and PF among students with disabilities. Our findings are the first to show that SADL has a significant effect on improving PAE and PF, thereby answering or confirming the hypothesis proposed in this study. The findings in our current study are in line with and supported by previous studies; for example, Rahayu et al. (2025) applied SA during differentiated teaching sessions in PE classes, and the results proved that the integration of SA and differentiated teaching had a positive impact on the development of higher learning engagement. Meanwhile, another study also reported that in the case of PE, a mobile application technology integrated into long-term PE learning can cause motivation to increase physical activity at school (Vega-Ramírez et al., 2020). Furthermore, it was also reported that in PE classes, fitness technology applications can be facilitators and sources of information for students and that technology is very important for students' physical exercise practices when learning

PE (Alonso-Fernández et al., 2022). In several developed countries, such as China, many universities have implemented modern technology into their teaching systems, and as a result, student learning performance has improved significantly (Zhang, Liu et al., 2025; Zhong et al., 2023). The findings in this study show that SA technology integrated into DL is an effective way for teachers to improve PAE and PF levels among students with disabilities.

The main strength of our current research is the design of an SADL programme for students with disabilities to enable them to learn effectively in PE classes. However, there are still limitations in this study that need to be addressed, such as the fact that the participants involved were only representatives of students from two schools in the city of Karawang (Indonesia), so we believe that the results cannot be generalised to other populations. Therefore, we suggest that future studies pay more attention to the number of participants and involve participants who are students with disabilities from several cities in Indonesia.

CONCLUSION

Thus, we highlight the importance of implementing long-term SADL programmes in PE classes as an effort to improve PAE and PF among students with disabilities. Our current research will contribute as an important innovation in PE teaching sessions by involving the use of SADL. In addition, it is hoped that the results of this study can change the paradigm of teachers to not always use traditional teaching methods and start trying to apply a new and interesting teaching model such as SADL.

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CONFLICT OF INTEREST

We confirm that there is no conflict of interest in our current study.

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