

Effects of Game-based Physical Education on Cardiovascular Endurance and Motivation Among Junior High School Students

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Abstract— This quasi-experimental study examined the effects of a six-week game-based physical education (GBPE) program on cardiovascular endurance and motivation among junior high school students. A total of 60 Grade 8 students (30 males, 30 females) from a public secondary school in the Philippines participated and were assigned to either an experimental group (GBPE) or a control group (traditional PE). Cardiovascular endurance was measured using the 20-Meter Shuttle Run Test (PACER), while motivation was assessed using the Physical Education Motivation Scale (PEMS). Results indicated a significant improvement in cardiovascular endurance in the experimental group ($p < 0.01$, Cohen's $d = 0.85$) compared to the control group. Motivation scores also increased significantly ($p < 0.05$, Cohen's $d = 0.62$), suggesting that GBPE enhances both physical fitness and intrinsic engagement. The findings highlight the potential of integrating game-based approaches into PE curricula to foster holistic student development.

Keywords— cardiovascular endurance, game-based learning, physical education, student motivation.

I. INTRODUCTION

Physical Education (PE) is an essential component of the school curriculum that promotes physical fitness, skill development, and lifelong healthy habits. It enhances physical well-being and contributes to mental health, social skills, and academic performance (Bailey et al., 2019). However, in many schools, PE is still delivered through traditional, drill-based methods that may not fully engage students or encourage long-term participation in physical activity. This lack of engagement can lead to declining interest, reduced motivation, and minimal improvement in fitness outcomes over time (Ntoumanis et al., 2021; Chen et al., 2020).

Cardiovascular endurance is one of the most critical components of health-related fitness, directly linked to reduced risks of chronic diseases, improved cognitive function, and better quality of life (Ortega et al., 2019; Janssen & LeBlanc, 2010). Adolescents with higher endurance levels are more likely to remain physically active in adulthood (Tomkinson et al., 2019; Lang et al., 2018). Nevertheless, traditional PE programs often fail to incorporate sufficiently dynamic and enjoyable activities to stimulate high-intensity physical engagement, limiting students' endurance development (Faigenbaum et al., 2020).

Game-Based Physical Education (GBPE) is an innovative approach that integrates structured games into the PE curriculum to achieve both skill and fitness objectives. Unlike conventional drills, GBPE incorporates elements of fun, competition, and cooperation, which can lead to higher levels of engagement and sustained physical activity (Casey & Kirk, 2021; O'Leary et al., 2019). International studies have demonstrated that game-based learning in

PE can improve physical outcomes such as cardiovascular endurance while simultaneously enhancing psychological factors like intrinsic motivation and enjoyment (Gao et al., 2018; Memmert et al., 2021; Hastie et al., 2011).

Motivation plays a vital role in sustaining participation in physical activity. According to Self-Determination Theory, fulfilling students' needs for autonomy, competence, and relatedness can significantly boost their willingness to participate in and enjoy PE (Deci & Ryan, 2020; Ryan & Deci, 2017). GBPE addresses these needs by offering choice, promoting skill mastery in a supportive environment, and encouraging teamwork (Sun et al., 2020; Dyson et al., 2016). This dual benefit makes it an attractive method for educators aiming to promote both physical and psychological gains in their students.

In the Philippine context, there remains limited empirical evidence on the effectiveness of GBPE in improving cardiovascular endurance and motivation among secondary school students. Most local PE programs still follow traditional teacher-centered models (Garcia et al., 2019). However, recent Philippine-based studies in sports pedagogy suggest that game-based and student-centered methods can enhance participation, enjoyment, and skill development (Sibayan & Ganai, 2021). Therefore, this study sought to address this gap by implementing a six-week GBPE program in a junior high school setting. The objective was to determine the effects of game-based physical education on students' cardiovascular endurance and motivation compared to traditional PE instruction.

II. METHODOLOGY

Research Design

A quasi-experimental pretest-post-test control group design was used in this study to investigate the effects of game-based physical education (GBPE) on cardiovascular endurance and motivation among junior high school students. This design enables comparison between an experimental group and a control group while using pretest scores to account for baseline differences (Creswell & Creswell, 2020). Recent studies highlight those quasi-experimental designs are effective in school-based research, particularly when random assignment is not feasible due to scheduling and administrative limitations (Allen et al., 2020).

The study involved Grade 8 classes from a public high school in the Philippines, with one assigned as the experimental group and the other as the control group. Both groups completed pretesting and post testing using standardized instruments for cardiovascular endurance and motivation. The experimental group participated in a six-week GBPE program featuring structured games aligned with PE competencies, while the control group followed the traditional curriculum. The pretest-posttest control group design was chosen to determine whether changes in outcomes could be attributed to the intervention rather than to external variables (Van den Berg et al., 2019).

Participants

The participants in this study were sixty Grade 8 students aged 13 to 14 years from Sablan National High School, a public high school in the Philippines. The students were selected using intact class groupings to maintain the

natural classroom structure, a common approach in educational research to preserve ecological validity (Cohen et al., 2021). To ensure comparability, baseline demographic and physical fitness characteristics were collected prior to the intervention, confirming that both groups had similar profiles in age, gender distribution, and initial fitness levels.

The students were randomly assigned by class into two groups: an experimental group ($n = 30$) that received game-based physical education (GBPE) sessions, and a control group ($n = 30$) that followed the traditional PE curriculum. The experimental group participated in structured games designed to meet PE learning competencies, while the control group engaged in skill-drill and exercise-based activities. Using a balanced group assignment approach in school-based interventions is recommended to minimize selection bias and improve the reliability of findings (Roberts et al., 2020).

Intervention

The experimental group participated in three 60-minute game-based physical education (GBPE) sessions per week over a six-week period. Each session incorporated a variety of activities, including modified tag games, relay races, invasion games, and cooperative challenges that were aligned with the prescribed physical education learning competencies. These activities were designed to promote cardiovascular endurance, agility, and teamwork while maintaining a high level of enjoyment and engagement among students. Previous research has shown that integrating structured games into PE can lead to higher physical activity intensity and improved fitness outcomes compared to traditional methods (Memmert et al., 2021).

In contrast, the control group engaged in conventional fitness drills and skill-based activities consistent with the school's existing PE curriculum. These sessions focused on repetitive practice of fundamental motor skills, aerobic exercises, and stretching routines. While traditional PE methods can support skill acquisition, studies indicate they may not consistently sustain student motivation or achieve optimal intensity for endurance development, especially among adolescents (Casey et al., 2020). The clear distinction in instructional approach between the two groups allowed for an accurate comparison of GBPE's effectiveness on both cardiovascular endurance and motivation.

Instruments

Cardiovascular endurance was measured using the 20-Meter Shuttle Run Test, also known as the Progressive Aerobic Cardiovascular Endurance Run (PACER). This field-based test involves participants running back and forth between two lines 20 meters apart in time with audio signals that progressively increase in speed. It is widely recognized as a reliable and valid measure of cardiorespiratory fitness among children and adolescents (López-Gil et al., 2020). The PACER test was administered according to standardized protocols to ensure consistency, and scores were recorded as the total number of laps completed before the participant could no longer maintain the pace.

Motivation toward physical education was assessed using the Physical Education Motivation Scale (PEMS), which has been validated in various Asian contexts, including among Filipino students (Chen et al., 2021). The PEMS evaluates multiple dimensions of motivation such as intrinsic motivation, identified regulation, introjected regulation, external regulation, and amotivation, following the framework of Self-Determination Theory. Participants rated their agreement with each item on a five-point Likert scale ranging from “strongly disagree” to “strongly agree,” with higher scores indicating stronger motivation toward PE participation.

Both instruments were chosen for their strong psychometric properties and suitability for use in a school setting. The PACER provides an objective, performance-based measure of endurance that can be easily administered in a PE class, while the PEMS offers a validated, culturally relevant tool for assessing students’ psychological engagement in the subject (Van den Berg et al., 2019).

Using both physical performance and self-report measures allowed the study to capture complementary aspects of the intervention’s impact, aligning with recommendations for multi-method assessment in physical education research (Allen et al., 2020).

Data Analysis

This study adhered to ethical standards for research involving human participants. Approval was obtained from the school administration prior to data collection. Informed consent was secured from students and their parents or guardians, and participation was voluntary. Confidentiality of all participants’ data was maintained, and results were reported in aggregate form to protect privacy.

III. RESULTS AND DISCUSSION

Table 1. Cardiovascular Endurance Scores (PACER laps)

Group	Pretest Mean $\pm$ SD	Posttest Mean $\pm$ SD	t-value (paired)	p-value	Effect Size (d)	t-value (independent)	p-value
Experimental	29.8 $\pm$ 4.5	38.6 $\pm$ 5.1	6.21	0.000**	0.85 (large)	5.576	0.000**
Control	30.2 $\pm$ 4.7	31.4 $\pm$ 4.9	1.12	0.270	0.15 (small)	—	—

The experimental group showed a significant increase in PACER laps (from 29.8 to 38.6), while the control group showed only a slight, non-significant improvement (from 30.2 to 31.4). The paired t-test confirmed that the experimental group’s gains were meaningful and large, while the control groups were not.

When comparing the two groups at post-test, the independent t-test showed that the experimental group outperformed the control group significantly ($t(58) = 5.576$, $p < 0.001$, large effect size). This clearly demonstrates that game-based PE improved cardiovascular endurance more than traditional PE.

These results are consistent with studies by Memmert et al. (2021), who showed that game-centered approaches promote higher physical exertion, and López-Gil et al. (2020), who emphasized that active play enhances

endurance and activity levels among youth. Similarly, Sibayan and Ganal (2021) in the Philippine setting reported that students in game-based PE achieved greater fitness improvements compared to those in conventional classes.

Table 2. Motivation Scores (PEMS total)

Group	Pretest Mean $\pm$ SD	Posttest Mean $\pm$ SD	t-value (paired)	p-value	Effect Size (d)	t-value (independent)	p-value
Experimental	3.21 $\pm$ 0.45	3.78 $\pm$ 0.40	4.03	0.001**	0.62 (medium)	4.191	0.000**
Control	3.25 $\pm$ 0.47	3.29 $\pm$ 0.50	0.42	0.676	0.05 (negligible)	—	—

The experimental group's motivation scores improved significantly from 3.21 to 3.78, while the control group's increase from 3.25 to 3.29 was negligible. The paired t-test revealed a medium effect in the experimental group, while the control group showed no meaningful change.

This implies that experimental group had significantly higher motivation at post-test compared to the control group ($t(58) = 4.191$, $p < 0.001$, large effect size).

The results of the paired t-test showed that the experimental group significantly improved in both endurance and motivation, while the control group did not show meaningful gains. Furthermore, the independent t-test revealed that the experimental group scored much higher than the control group after the six-week program.

These findings support Sun et al. (2020), who explained that student-centered and play-based environments increase intrinsic motivation, and Casey et al. (2020), who noted that active engagement in PE promotes long-term participation. Garcia et al. (2019) also found that motivational climates in PE enhance student engagement, further confirming the current results.

IV. CONCLUSION

Based on the results and discussion, game-based physical education (GBPE) significantly improved cardiovascular endurance among junior high school students, as evidenced by higher PACER scores compared to the control group. It also enhanced students' motivation toward physical education, showing medium to large effect sizes, while the control group exhibited negligible change. The study confirms that GBPE is more effective than traditional PE methods in fostering both physical fitness and intrinsic engagement. Moreover, Philippine-based evidence supports GBPE as a promising approach, consistent with international findings on the benefits of student-centered, play-based instruction. Overall, GBPE addresses both the physical and psychological needs of learners, promoting holistic development and encouraging lifelong participation in physical activity.

V. RECOMMENDATION

Based on the findings and conclusions of this study, the following recommendations are made: Physical education teachers should consider integrating game-based physical education (GBPE) as a regular instructional approach,

selecting games that align with learning competencies while ensuring student engagement. Schools should also provide training, resources, and scheduling support to PE teachers to effectively implement GBPE. Furthermore, collaboration among teachers is encouraged to share best practices and develop effective game-based lesson plans. Lastly, further studies should examine the long-term effects of GBPE, explore its impact on different age groups and cultural contexts, and investigate additional outcomes such as teamwork, social skills, and problem-solving abilities.

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