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THE EFFECTIVENESS OF PHYSICAL EDUCATION CLASSES THROUGH COLLABORATIVE LEARNING METHODS FOR THE PHYSICAL DEVELOPMENT OF 11TH-GRADE STUDENTS IN VIETNAM

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Abstract

Introduction. Collaborative Learning (CL) is a group learning method that involves mutual support and assistance among individual students to achieve learning goals. The purpose of this study is to assess the effectiveness of a 14-week Physical Education (PE) class using the CL method in enhancing the physical development of 11th-grade students. ***Material and Methods.*** Eighty healthy students were randomly selected and divided into two groups: the experimental group with 40 students applying the CL method in PE classes, and the control group with 40 students studying PE using conventional methods. In this study, five fitness tests were used such as a 30-s sit-up test, a 30-m sprint test, a 4 × 10-m shuttle run test, a standing long jump test, and a 5-min running field test. ***Results.*** After 14 weeks of experimentation, independent t-test results indicated a significant difference in the mean values between the experimental and control groups at the threshold of $p < 0.05$. Paired t-test results for the mean values before and after the experiment in both groups also showed a difference, with the physical fitness growth rate of the experimental group being higher than that of the control group. Particularly, the control group exhibited a post-experiment value that had a negative significance. ***Conclusions.*** This demonstrates that the experimental results serve as an illustration, confirming the effectiveness of the CL method in high school PE classes. Teachers should enhance the use of CL in the future to achieve higher learning goals.

Key words: collaborative learning, physical education, physical fitness, high school students, Vietnam

Introduction

CL is a teaching method in which students work in small groups to assist each other in their learning [1]. CL has been used worldwide. It is becoming increasingly popular internationally because of its various benefits related to social, psychological, academic, and evaluative aspects of the teaching and learning process [2]. CL impacts academic achievement, attitudes, and perceptions of students, while also providing individual support for the learning process [3, 4]. For elementary school students, this method is advantageous over conventional ones. It has a significant impact on students' academic achievement, while also aiding in the development of students' creative thinking [5, 6, 7]. The collaborative teaching technique has an impact on the development of problem-solving skills, especially in STEM education. It provides students with a sense of excitement and offers them high-quality opportunities for teamwork [8, 9, 10]. Furthermore, CL brings additional value and benefits to students compared to conventional teaching methods. It helps students achieve their learning goals more easily and develop social skills [3, 7, 11, 12]. However, this method also presents significant challenges and obstacles for teachers when applying this approach in the teaching process [13, 14].

In PE, the CL method has also been extensively researched by many authors [15, 16]. In 2000, in the article "The use of cooperative learning as a social enhancer in PE", the author investigated the impact of collaborative teaching methods on the development of students' social helping behavior [17]. In his study, Dyson Ben identified that CL has a positive impact on PE. The article presented five essential components of CL to help educators maximize the learning process (team formation, positive interdependence, individual accountability, positive social interaction, and group processing) and five structures of CL (think-share-perform; pairs-check-perform; jigsaw perform; co-op play; and learning teams) [18].

CL brings numerous benefits and value to PE. The use of CL in PE can shift from the exclusive development of students' skills to an open-ended process where the diversity of students transforms and influences each other [19]. In PE classes, CL helps students engage in verbal exchanges and discussions among peers in teaching team sports. This creates favorable conditions for the development of motor skills and strategic abilities [20]. It also contributes to improving academic performance in physical, cognitive, social, and emotional domains [21, 22, 23, 24]. Furthermore, CL is also an effective pedagogical model that can be used to enhance problem-solving skills, thereby generating positive learning outcomes in PE for both elementary and secondary school students [25, 26, 27, 28]. The changes in the CL method have led to a shift in the classroom atmosphere among students. Students feel more valued and integrated, leading to more positive engagement in PE classes [29].

To achieve high-quality results in the field of PE in the upcoming period, it is necessary to innovate the content and teaching methods of PE towards enhancing practical activities within groups. This creates opportunities for learners to collaborate and engage in discussions during their studies and training,

aiming to spark interest in the learners. As a result, the physical fitness of students will be elevated, and the effectiveness of PE classes will be improved. However, discussions should also focus on how teachers can effectively enhance students' physical fitness to meet the educational goals set out in the teaching plan, using CL methods.

There have been numerous studies on CL in PE; however, none of them have specifically investigated the use of CL methods to enhance physical fitness and increase interest among students. This research examines the impact of CL methods and conventional methods on the physical fitness and academic interest of students in PE. Therefore, two proposed issues in this study are: 1. Compare the differences in students' physical fitness in two teaching situations: CL and conventional teaching methods; 2. Evaluate the growth rate of the experimental group and the control group after the experiment.

Material and Methods

Participants and Setting

The research sample included 80 11th-grade students from the High School affiliated with Thai Nguyen University of Education, studying PE in the curriculum from grades 1 to 12. They were divided into 2 groups. The experimental group consisted of 40 students from class 11A1 (20 male students and 20 female students) attending PE classes in which CL methods were applied. The teacher leading this group was highly qualified and experienced in CL. The control group consisted of 40 students from class 11A2 (20 male students and 20 female students) attending PE classes in which conventional teaching methods were applied.

The procedures for PE classes using the CL method were conducted in classrooms, sports arenas, and the school's stadium, adapting to the research characteristics and involving active participation from students after classes. Safety precautions were implemented during the classes. Both groups of students were in good health, with an average age of 16.05 ± 0.56. None of the students had previously experienced classes in which CL as a teaching model was applied. They were informed of the test procedures before providing written consent. All participants were involved in the study voluntarily, and they delivered written informed consent prior to the commencement of the experiment. They could withdraw from the study at any stage without giving a reason. The study was conducted following the principles of the Declaration of Helsinki. This research was approved by the Scientific Research & Education Council at Thai Nguyen University of Education according to Decision No. 1780/QD-DHSP, dated July 19, 2022 of the Rector of Thai Nguyen University of Education.

Curriculum

We selected Volleyball for a 14-week duration, equivalent to 28 class sessions (2 sessions per week; 45 minutes per session), to implement CL methods for the experimental group. The main content for Volleyball included High Pass Technique, Low Pass Technique, and Volleyball Rules.

Specifically:

* Applying the CL method to organize and control the teaching process of "High Pass Technique" and "Low Pass Technique"

a) Preparation:

- Designing a teaching plan using CL methods for "High Pass Technique" and "Low Pass Technique" in Volleyball.
- The teacher uses CL to organize and control the new lesson content for teaching the two techniques mentioned.

Activities of the teacher (T) and students (Ss):

- The teacher randomly divides the class into 4-6 groups.
- The teacher assigns specific tasks to each individual and group. These tasks need to be tailored to the capabilities of each individual and group.

b) Implementation:

Step 1 – Assigning learning tasks: The teacher introduces the content of the lesson. The teacher analyzes, explains, and demonstrates the techniques. The teacher divides the experimental group of students (40 students) into 4 groups, with each group consisting of 10 students. The teacher informs the groups in terms of the number of repetitions, breaks, duration, and method of implementation. The teacher assigns group 1 to perform wall passing exercises, group 2 to perform ground passing, group 3 to perform passing back and forth to each other within a netted court, and group 4 to perform passing the ball in a court without a net.

Step 2 – Implementing learning tasks:

For "High Pass Technique": Team members actively collaborate to perform the assigned tasks. Initially, each group spends 5-7 minutes performing movements without the ball to simulate. Then, each group spends 10-12 minutes performing movements with the ball with different requirements: group 1 passes the ball to the ground; group 2 passes the ball against the wall; group 3 passes the ball back and forth within a netted court; group 4 passes the ball in a court without a net. Groups actively plan to achieve common goals and assign tasks to individuals.

For "Low Pass Technique": Team members actively collaborate to perform the assigned tasks. Initially, each group spends 5-7 minutes performing movements without the ball to simulate. Then, each group spends 10-12 minutes performing movements with the ball with different requirements: group 1 passes the ball low against the wall; group 2 passes the ball low with someone assisting in throwing the ball; group 3 passes the ball low back and forth within a netted court; group 4 passes the ball low in a court without a net. Groups actively plan to achieve common goals and assign tasks to individuals.

Step 3 – Presenting and evaluating results: Representatives from each group (or the entire group) present the results through a demonstration of the group's work. Other students observe and listen, providing comments and feedback. The teacher guides students in listening, observing, and giving positive feedback.

c) Summary and evaluation:

The teacher guides students in summarizing the lesson. The performances of each group are evaluated, and conclusions are drawn regarding the learning process. Experiences are shared with the next group. After receiving feedback and comments from students, the teacher summarizes all stages of implementing the techniques and highlights key points for practice or application. The teacher assigns tasks for students to research and prepare. Students accept the new tasks seriously and prepare for the upcoming lessons based on the guidance provided by the teacher.

* The teacher applies the jigsaw technique in the analysis of both "High Pass Technique" and "Low Pass Technique."

The teacher assigns students a task to solve: Analyze the "High Pass Technique" and "Low Pass Technique" in volleyball. Provide an illustrative example of a real-life situation using these techniques.

a) Round 1: Expert

Lesson A: How is the preparation posture executed? Provide illustrative examples and analysis.

Lesson B: What is the hand position and contact area of the hand with the ball? Provide illustrative examples and analysis.

Lesson C: How is the passing motion executed? Provide illustrative examples and analysis.

Lesson D: What is the follow-through motion after passing the ball? Provide illustrative examples and analysis.

The teacher divides the experimental class into 4 groups, with each group consisting of 10 students. The assignment is as follows: Group 1 receives Lesson A; Group 2 receives Lesson B; Group 3 receives Lesson C; and Group 4 receives Lesson D. Study sheets are distributed to students, numbered from 1 to 4. The teacher informs the students about the individual and group work time. During the learning task, it is essential to ensure that each member becomes an "expert" in the assigned lesson and has the ability to present the group's task results in Round 2.

b) Round 2: Jigsaw

The teacher re-groups as follows: Each new group has 8 members, with at least 3 members from different groups with different lessons. The teacher informs about the duration of the tasks. The experts present the content and opinions of their respective groups from Round 1. After all members share their information, the new groups discuss and agree on a solution for the initial complex task. Representatives from each group present and share the results.

*Applying the rolling technique in teaching volleyball rules

Discussion on regulations regarding volleyball court and equipment: Court dimensions; serving zone; net height; ball circumference; ball pressure.

- The teacher presents the content: The regulations of volleyball rules regarding the court and equipment, guiding students to discuss to avoid confusion.
- The teacher divides the class into 2 groups (2 concentric circles), arranging it so that students in the inner circle sit opposite those in the outer circle. Students in the inner circle begin discussing the regulations of volleyball rules regarding the court and equipment with students sitting in the outer circle opposite them.
- After 2 minutes, students in the outer circle remain seated, while students in the inner circle move clockwise to form new pairs with others, continuing the discussion on the presented topic.
- The teacher checks the content students have gathered during the discussion with their peers, inviting some students to share their discussion results or propose solutions. The teacher provides general comments and conclusions.

Experiment procedure

The experimental lectures were conducted in 14 weeks in an academic year. During the experimentation process, we identified the required objectives and focus of the lesson before designing discussion exercises. It is crucial to determine at what level students can perform the exercises and how much time should be allocated for discussion before designing the exercises. Afterward, we needed to anticipate the type of training group, how many students would be involved, and whether the discussion would take the form of a comparative activity or an exchange. We also took into consideration whether the exercises should be assigned for students to prepare at home or during the class. For exercises that require critical thinking or have challenging training content, the teacher would assign them beforehand for students to prepare at home.

When designing group training exercises, we also remained flexible in selecting various types of group exercises to avoid monotony and stimulate students' interest in learning. The types of group exercises used in teaching PE in general and volleyball content in particular can be considered valuable resources for teachers interested in this teaching method. However, teachers can be creative in adding other types of exercises for diversity and richness in the learning experience.

In cooperative learning sessions, we did not allocate the entire time to discussions and group exercises. Instead, we focused on discussing complex, central, intriguing issues that require students to engage in critical thinking. Depending on the amount of educational content in each lesson, we conducted discussions and exercises with an appropriate number of rounds. On average, for a single class, we usually designed discussion exercises for one to two rounds. We often organized group training and discussions at the core of the lesson, particularly focusing on new lesson content in the core part.

From the beginning of the research until its conclusion, the experimental phase was implemented in PE classes based on the CL method for 14 weeks. One week before the experiment, we conducted a fitness test for both the control group and the experimental group. One week after completing the experiment, we continued to assess and compare the fitness levels of students in both groups to draw comparisons and make evaluations.

Collecting and analyzing data

The data analysis was carried out from the perspectives of various individuals, including students, teachers, and PE experts, using measurements. The fitness development tests for students were conducted by the research author, a measurement assistant, and two recorders who documented the test results in the registration forms. To assess the effectiveness of PE classes designed using the CL method on students' physical development, we utilized 5 criteria (tests) as data collection tools for evaluating physical development in that study: 30-s sit-up test (to measure abdominal muscular strength and endurance of the abdominals and hip-flexors, important in back support and core stability), 30-m sprint test (to determine acceleration and speed), 4 × 10-m shuttle run test (agility), standing long jump test (to measure the explosive power of the legs), and 5-min running field test (to measure endurance). They are the criteria issued by the Ministry of Education and Training of Vietnam in 2008 for assessing and classifying the physical fitness of students based on their age. [30], and they were also utilized in the author's research when evaluating the physical development of students [31, 32]

All data is represented in the form of mean values and standard deviations ($\bar{x} \pm SD$). The obtained data was analyzed using the Statistical Package for the Social Sciences (SPSS) for Windows, version 20. Descriptive analysis was employed to identify the characteristics of the subjects. Independent sample t-test was used to assess differences in each experiment between the control group and the experimental group. Paired sample t-test was utilized to determine differences between pre-experiment and post-experiment. The statistical significance level was set at $p < 0.05$.

Results

In this section, the data obtained from statistical experiments is analyzed, and the overall results are presented in line with the hypotheses and based on the development of physical qualities observed during the application of the CL method.

Prior to the experiment, we conducted a fitness assessment of students in the experimental and control groups for comparison.

Tables 1 and 2 show that in all 5 fitness assessment tests for male and female 11th-grade students in both control and experimental groups, there is no significant difference between the pre-experiment values ($p > 0.05$). This means that before the experiment, the fitness levels of the two groups were equivalent, ensuring an entirely objective grouping, meeting the experimental organization requirements.

After 12 weeks of experimenting with the application of the CL method in teaching PE to 11th-grade students, we conducted an evaluation test post-experiment. The purpose was to compare the average values obtained in the 5 tests between the control and experimental groups, providing a basis for assessing the effectiveness of applying the CL method in practice. The evaluation results with the independent sample t-test are presented in Tables 3 and 4.

Tables 3 and 4 indicate that after the experiment, in the 5 fitness assessment tests for both male and female 11th-grade students in the experimental and control groups, there is a significantly positive difference, with significance levels at $p < 0.05$ favoring the experimental group. Therefore, it can be observed that the application of the CL method in teaching PE has positively impacted the physical development of students and yielded good results.

In addition to the independent t-test, we compared the pre-test and post-test mean values of the control and experimental groups, evaluating the growth rate of both groups.

Tables 5 and 6 demonstrate that in the experimental group, the paired sample t-test results show a significantly positive difference, with a significance level of $p < 0.0001$, in all 5 fitness assessment tests conducted both before and after the experiment. Particularly, the post-experiment mean values compared

Table 1. Pre-test independent t-test results on the physical fitness of male students in the control group and the experimental group

Test	Groups	n	$\bar{x} \pm SD$	t - Test	
				t	p
Standing long jump (cm)	Experimental	20	188.7500 ± 10.24374	-0.061	.952
	Control	20	188.9500 ± 9.08136		
30-m sprint (s)	Experimental	20	5.7700 ± 0.22560	-1.400	.178
	Control	20	5.8725 ± 0.18459		
30-s sit-up test (times)	Experimental	20	14.0000 ± 1.29777	-1.606	.125
	Control	20	14.7000 ± 1.38031		
4 × 10-m shuttle run (s)	Experimental	20	12.6175 ± 0.20981	0.245	.809
	Control	20	12.6025 ± 0.19833		
5-min running field (m)	Experimental	20	940.0000 ± 16.85854	-0.775	.448
	Control	20	944.7500 ± 21.67190		

x – mean values, SD – standard deviations.

Table 2. Pre-test independent t-test results on the physical fitness of female students in the control group and the experimental group

Test	Groups	n	$\bar{x} \pm SD$	t - Test	
				t	p
Standing long jump (cm)	Experimental	20	154.2500 ± 9.32385	0.175	.863
	Control	20	153.9000 ± 8.40989		
30-m sprint (s)	Experimental	20	6.6850 ± 0.25655	1.008	.326
	Control	20	6.6000 ± 0.24921		
30-s sit-up test (times)	Experimental	20	14.4000 ± 0.99472	-0.770	.451
	Control	20	14.7500 ± 1.58529		
4 × 10-m shuttle run (s)	Experimental	20	12.9250 ± 0.28168	0.699	.493
	Control	20	12.8650 ± 0. 30353		
5-min running field (m)	Experimental	20	823.1500 ± 22.96513	0.023	.982
	Control	20	823.0000 ± 17.50188		

x – mean values, SD – standard deviations.

Table 3. Post-test independent t-test results on the physical fitness of male students in the control group and the experimental group

Test	Groups	n	$\bar{x} \pm SD$	t - Test	
				t	p
Standing long jump (cm)	Experimental	20	240.0000 ± 17.69627	11.679	.000*
	Control	20	193.0500 ± 9.78976		
30-m sprint (s)	Experimental	20	4.9875 ± 0.27762	10.328	.000*
	Control	20	5.7960 ± 0.18543		
30-s sit-up test (times)	Experimental	20	18.1000 ± 1.61897	4.568	.000*
	Control	20	15.7500 ± 1.33278		
4 × 10-m shuttle run (s)	Experimental	20	11.9150 ± 0.20717	9.349	.000*
	Control	20	12.4725 ± 0.21304		
5-min running field (m)	Experimental	20	1077.5000 ± 33.22570	13.973	.000*
	Control	20	946.0000 ± 21.74009		

x – mean values, SD – standard deviations, * – statistical significance.

Table 4. Post-test independent t-test results on the physical fitness of female students in the control group and the experimental group

Test	Groups	n	$\bar{x} \pm SD$	t - Test	
				t	p
Standing long jump (cm)	Experimental	20	187.2500 ± 13.31353	10.874	.000*
	Control	20	147.9000 ± 8.68089		
30-m sprint (s)	Experimental	20	5.8520 ± 0.27737	6.501	.000*
	Control	20	6.3960 ± 0.22984		
30-s sit-up test (times)	Experimental	20	17.8500 ± 1.72520	4.997	.000*
	Control	20	15.3000 ± 1.34164		
4 × 10-m shuttle run (s)	Experimental	20	12.1450 ± 0.25900	7.850	.000*
	Control	20	12.6850 ± 0.24926		
5-min running field (m)	Experimental	20	873.0000 ± 19.42597	9.713	.000*
	Control	20	818.2500 ± 14.35224		

x – mean values, SD – standard deviations, * – statistical significance.

Table 5. Pre-test and post-test paired sample t-test results on the physical fitness of male students in the experimental group

Test	Time	$\bar{x} \pm SD$	t	p	Percentage of change
Standing long jump (cm)	Pre-	188.7500 ± 10.24374	12.121	.000*	27.152
	Post-	240.0000 ± 17.69627			
30-m sprint (s)	Pre-	5.7700 ± 0.22560	16.202	.000*	13.692
	Post-	4.9875 ± 0.27762			
30-s sit-up test (times)	Pre-	14.0000 ± 1.29777	15.158	.000*	29.286
	Post-	18.1000 ± 1.61897			
4 × 10-m shuttle run (s)	Pre-	12.6175 ± 0.20981	22.003	.000*	5.564
	Post-	11.9150 ± 0.20717			
5-min running field (m)	Pre-	940.0000 ± 16.85854	19.037	.000*	14.628
	Post-	1077.5000 ± 33.22570			

x – mean values, SD – standard deviations, * – statistical significance.

Table 6. Pre-test and post-test paired sample t-test results on the physical fitness of female students in the experimental group

Test	Time	$\bar{x} \pm SD$	t	p	Percentage of change
Standing long jump (cm)	Pre-	154.2500 ± 9.32385	14.278	.000*	21.394
	Post-	187.2500± 13.31353			
30-m sprint (s)	Pre-	6.6850 ± 0.25655	27.486	.000*	12.461
	Post-	5.8520 ± 0.27737			
30-s sit-up test (times)	Pre-	14.4000 ± 0.99472	10.262	.000*	23.958
	Post-	17.8500 ± 1.72520			
4 × 10-m shuttle run (s)	Pre-	12.9250 ± 0.28168	15.305	.000*	6.035
	Post-	12.1450 ± 0.25900			
5-min running field (m)	Pre-	823.1500 ± 22.96513	23.509	.000*	6.056
	Post-	873.0000 ± 19.42597			

x – mean values, SD – standard deviations, * – statistical significance.

to the pre-experiment mean values show a high growth rate: in the male experimental group, the test with the highest growth rate is 30-s sit-up test (times) measuring abdominal muscular strength and endurance of the abdominals and hip-flexors, important in back support and core stability at 29.286%, followed by standing long jump (cm) measuring the explosive power of the legs at 27.152%, and 5-min running field test (m) measuring endurance at 14.628%. In the experimental group of female students, the test with the highest growth rate is 30-s sit-up test (times) at 23.958%, followed by standing long jump (cm) at 21.394%. This demonstrates the positive values and significance of the CL method in enhancing physical fitness for students while studying PE.

Table 7 demonstrates that in the control group of male students, the results of the paired sample test assessing physical fitness before and after the experiment also showed a difference at $p < 0.001$ with 3 tests: 30-s sit-up test (times), 30-m sprint (s), 4 × 10-m shuttle run (s), standing long jump (cm) at $p < 0.05$, except for 5-min running field test (m) where there is no significant difference ($p > 0.05$). However, the growth rate of the post-experiment mean values compared to the pre-experiment mean values is low, with the highest increase being 30-s sit-up test (times) reaching 6.667%, 5-min running field test (m) at 0.132%. In the female control group (table 8), negative significance in the post-experiment average values is observed for standing long jump (cm) and 5-min running field test (m), whereas there is a difference of $p < 0.05$ in 30-m sprint (s), 30-s sit-up test (times), and 4 × 10-m shuttle run (s). However, the growth rate of the post-experiment mean values compared to the pre-experiment mean values is low, with the highest increase being 30-m sprint (s) at 4.762%. This indicates that teaching PE using traditional methods does have an impact on students' physical fitness, but the growth rate is very low, and in some cases, there is even a decrease in performance compared to the initial achievements. These are the existing issues that need improvement and innovation in teaching methods in PE.

Discussion

After the experiment on all 5 physical fitness tests for both male and female 11th-grade students in the experimental group using the CL method, there was much higher development compared to the control group. This difference is significantly positive, favoring the experimental group. The results after the

Table 7. Pre-test and post-test paired t-test results on the physical fitness of male students in the control group

Test	Time	$\bar{x} \pm SD$	t	p	Percentage of change
Standing long jump (cm)	Pre-	188.9500 ± 9.08136	2.479	.023	2.124
	Post-	193.0500 ± 9.78976			
30-m sprint (s)	Pre-	5.8725 ± 0.18459	3.915	.001*	1.320
	Post-	5.7960 ± 0.18543			
30-s sit-up test (times)	Pre-	14.7000 ± 1.38031	5.294	.000*	6.667
	Post-	15.7500 ± 1.33278			
4 × 10-m shuttle run (s)	Pre-	12.6025 ± 0.19833	7.935	.000*	1.042
	Post-	12.4725 ± 0.21304			
5-min running field (m)	Pre-	944.7500 ± 21.67190	0.721	.480	- 0.132
	Post-	946.0000 ± 21.74009			

x – mean values, SD – standard deviations, * – statistical significance.

Table 8. Pre-test and post-test paired t-test results on the physical fitness of female students in the control group

Test	Time	$\bar{x} \pm SD$	t	p	Percentage of change
Standing long jump (cm)	Pre-	153.9000 ± 8.40989	2.188	.041	-4.057
	Post-	147.9000 ± 8.68089			
30-m sprint (s)	Pre-	6.6000 ± 0.24921	2.703	.014*	4.762
	Post-	6.3960 ± 0.22984			
30-s sit-up test (times)	Pre-	14.7500 ± 1.58529	2.979	.008*	3.595
	Post-	15.3000 ± 1.34164			
4 × 10-m shuttle run (s)	Pre-	12.8650 ± 0. 30353	3.327	.004*	1.419
	Post-	12.6850 ± 0.24926			
5-min running field (m)	Pre-	823.0000 ± 17.50188	1.174	.255	-0.581
	Post-	818.2500 ± 14.35224			

x – mean values, SD – standard deviations, * – statistical significance.

experiment show much higher growth compared to before the experiment in the experimental group. This confirms the effectiveness of applying the CL method in developing physical fitness in teaching PE to 11th-grade students in Vietnam. Our viewpoint is also shared by many researchers who have demonstrated the effectiveness of the CL method for students, with Lee [33] being a notable example with his research "Effects of a cooperative learning strategy on the effectiveness of physical fitness teaching and constraining factors". The study has demonstrated significant overall physical fitness improvement within the cooperative learning group between the pre-test and post-test, with statistically significant differences observed in sit-ups and flexibility, specifically bending and stretching the knees. CL is considered an effective approach for achieving physical fitness in students [33]. The author's research findings are also consistent with our research results.

In "The effect of movement education based on CL method on the development of basic motor skills of primary school 1ST-grade learners", Altınkök demonstrates the impact of physical activities based on the CL method on the development of basic motor skills, ball control with feet and hands, coordination, agility, and dynamic balance skills of primary school students in grade 1. Although different assessment tests were used, the research results strongly support our findings [34].

In "Effects of an 8-week CL intervention on PE students' task and self-approach goals, and emotional intelligence", Rivera-Pérez et al. demonstrate that CL in PE classes helps increase students' self-approach goals and their control, regulation of emotions, and empathy. The research reinforces the use of CL in PE, as it can guide students toward more adaptive motivational patterns and enhance their emotional intelligence development [35]. The research results also demonstrate the effectiveness of the CL method in PE classes.

Kusuma [36] has similar evaluations to our perspective in the study "The effect of CL approach, competitive and physical fitness on basketball dribble skills". The author points out that the learning outcomes in basketball skills and physical fitness of students taught using the CL method would be better than those of students taught through a competitive approach.

León et al. [24] have similar observations regarding the effectiveness of the CL method on PE learning outcomes. The author demonstrates that cooperation in PE classes showed a positive correlation with academic results, where positive emotions intervened as intermediate factors for successful learning.

Moreover, there are numerous studies on the effectiveness of the CL method in improving learning outcomes as well as developing fundamental motor skills and achieving goals and success in PE classes. Although these studies [17, 37, 38] vary in terms of subjects, they have greatly supported our research.

Conclusions

The process of applying the CL method in PE class with the content of teaching Volleyball to 11th-grade students has yielded positive results and addressed our initial research question. Teaching according to the CL method helps students develop physical fitness, enhance teamwork, encourage and support each other in activities, and increase social sharing with successful achievements among peers. After 14 weeks of experimentation, there is a significant difference in physical fitness between the experimental and control groups, with a leaning towards the experimental group. Additionally, the experimental group has shown much higher growth rates compared to the control group. This indicates that using the CL method in PE classes can make significant contributions to each student's learning process, and high school teachers should actively research and apply this teaching method. It can be affirmed that the method can greatly contribute to realizing education and enhancing the quality of education provided in the teaching-learning process in today's era, where individual differences are emphasized. This method is also useful for maintaining lifelong and long-term learning. Furthermore, it can be argued that when individuals contribute to a group that aligns with their skills and abilities, it will increase the level of learning within the group.

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