

# Enhancing Learning Outcomes in Physical Education through Project-Based Learning: A Quasi-Experimental Study on Butterfly Stroke Instruction

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## ABSTRACT

The butterfly stroke is widely regarded as the most technically and physically demanding swimming style, often posing challenges for physical education students due to its complex coordination of arm movements, leg kicks, and breathing techniques. Project-Based Learning (PjBL) has shown promise in enhancing student engagement, collaboration, and reflective learning in physical education settings. This quasi-experimental study aimed to evaluate the effectiveness of PjBL in improving students' learning outcomes for the butterfly stroke. Two groups participated: an experimental group exposed to PjBL methods and a control group that received traditional instruction. The intervention was conducted over a designated instructional period within a swimming course. Statistical analysis revealed a significant difference in learning outcomes between the two groups. The experimental group achieved a mean gain score 10.83% higher than the control group, with a  $t(70) = 8.102$ ,  $p < .001$ . The 95% confidence interval for the mean difference ranged from 8.17% to 13.50%, indicating a consistent and substantial improvement in performance attributed to the PjBL approach. Findings suggest that PjBL fosters improved psychomotor, cognitive, and affective domain development in students learning the butterfly stroke. Enhanced student motivation, teamwork, and reflective engagement appear to be key factors contributing to the learning gains observed. Project-Based Learning significantly enhances learning outcomes in swimming lessons focused on the butterfly stroke. This pedagogical approach can effectively support the development of complex motor skills in physical education.

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## 1. INTRODUCTION

One of the most technically and physically demanding swimming strokes is the butterfly stroke (Alawamleh & AlKasasbeh, 2024). From the swimmer's standpoint, butterfly stroke speed calls for more muscle strength and flexibility than other swimming forms (Faradila NN et al., 2020). It calls for great endurance, lots of strength, and exact coordination. The stroke calls for harmonic execution of synchronous arm movement, a strong dolphin kick, and rhythmic breathing (Sriningsih et al., 2017).

Given these expectations, it is not shocking that many physical education students find it difficult to become proficient in this swimming style. The fundamentals of the butterfly stroke are the synchronized arm and leg motions, which many students find very challenging (Nakashima & Tsai, 2017).

Additionally, breathing patterns often pose significant challenges due to limited inhalation time, which just allows for a brief inhalation when the head rises above the surface (Kretschmann, 2017). These difficulties usually cause irritation, lack of confidence, and finally lower students' drive to keep learning the stroke. Physical education still frequently uses conventional methods of teaching swimming, such as demonstration followed by repeated practice. Although these approaches give students concrete models to copy, they may fall short in encouraging strong conceptual understanding (Qi et al., 2023). Students' capacity to completely grasp and improve the butterfly stroke technique is hampered by limited practice time, inadequate chances for self-examination, and a lack of tailored feedback.

Project-Based Learning (PjBL) shows promise as a substitute. Emphasizing learning by active investigation, teamwork, and reflection, PjBL is a student-centered educational method (Aley et al., 2024). Within the framework of swimming teaching, especially the butterfly stroke, PjBL can be used via projects, including producing self-guided learning modules, creating instructional movies, or analyzing stroke mechanics via recorded footage (Hartanto et al., 2025). Students who use the PjBL model are not only honing their technique but also interacting with the biomechanical ideas underlying it, evaluating their strengths and shortcomings, and teaming to accomplish learning objectives. By helping students to overcome obstacles they face during their education, this technique can greatly increase their learning motivation, active participation, and critical thinking abilities (Harida et al., 2023).

Moreover, using PjBL to teach the butterfly stroke gives students a more relevant and individualized education. Students who actively participate in organizing and implementing their initiatives grow more personally liable for their education (Mashud et al., 2023). Their results in the cognitive, emotional, and psychomotor areas all improve from this. Therefore, including PjBL into physical education has enormous potential to improve general learning quality, especially in teaching difficult motor skills like the butterfly stroke.

Constructivist learning theory—especially the writings of John Dewey, Jean Piaget, and Lev Vygotsky—grounds Project-Based Learning (PjBL) (Bada & Olusegun, 2015). According to this perspective, students learn best when they participate actively in the learning process using relevant assignments and practical problems. Through long-term, inquiry-based projects requiring critical thinking, problem-solving, teamwork, and self-reflection, PjBL invites students to take responsibility for their education (Krahenbuhl, 2016). Project-Based Learning (PjBL) presents a great way for students in the context of physical education to actively participate in investigating movement ideas and learning technical skills via relevant, real-world projects. Rooted in constructivist learning theory, PjBL stresses the learner's part in creating knowledge employing hands-on experience, group projects, and introspection. Students are urged to examine movement tactics, solve challenges, and assess their performance in this learner-centered environment, therefore rendering the learning process as valuable as the result. This method fosters autonomy, motivation, and critical thinking—qualities vital for long-term physical education development in addition to deeper knowledge and skill acquisition.

The part reflection and cooperation in skill development. Emphasizing teamwork and introspection is central to PjBL. Constructivist theory holds that knowledge building through conversation and shared experiences might help to mediate learning, utilizing group projects. Encouragement of students to assess their skill progress, grasp performance problems, and create future learning objectives depends on reflection, individual and group-based (Sujarwo et al., 2023) (Mattar, 2018). In swimming training, these reflective processes can boost metacognitive awareness of learning progress and help to improve technique.

Physical education's learning goals usually three areas define learning objectives in physical education: cognitive (knowledge and comprehension), emotional (attitudes, motivation, values), and psychomotor (physical skills and performance). Teaching difficult motor skills like the butterfly stroke requires making sure students not only pick up the technical abilities but also grow in confidence, endurance, and critical awareness of their learning development (Hartanto et al., 2025). By encouraging autonomy, creativity, and deep learning experiences, which support these multidimensional learning objectives, PjBL has been proven to support these outcomes.

Three difficulties in learning the butterfly stroke. Because of its intricacy of motions, which call for synchronous coordination of both arms and legs as well as exact breathing control, the butterfly stroke is sometimes regarded as the most difficult swimming style (Hořub et al., 2021). Studies show that inexperienced swimmers sometimes find it difficult to sustain energy, keep rhythm, and achieve good body alignment (Qi et al., 2023). Conventional teaching strategies, which mostly focus on repetition and demonstration, might not be sufficient to meet the particular needs or give enough chances for error analysis and reflection. Consequently, other teaching strategies such as PjBL could provide more flexible and interesting learning surroundings.

Previous research has highlighted several strategies that can improve swimming instruction. For instance, grouping swimmers based on speed and using supportive aids such as fins have been shown to streamline training sessions without hindering the progress of slower learners (Sellés-Pérez et al., 2023). In parallel, Project-Based Learning (PjBL) has demonstrated significant benefits in educational contexts, particularly in fostering creativity, increasing student engagement, and enhancing reflective learning (Mihardi, 2013; Fatmawati et al., 2023). Furthermore, evidence suggests that teaching styles, especially those focused on structured training, positively influence learner confidence and the overall effectiveness of swimming education (Saputra et al., 2019).

Despite these insights, limited research has explored the application of PjBL to the development of complex motor skills—specifically the butterfly stroke, which demands high levels of coordination and technical precision. While PjBL has gained traction in disciplines such as science and language, its integration into physical education remains underdeveloped. Recent studies have begun to recognize its potential to enhance motor skill acquisition, boost motivation, and support deeper cognitive and reflective engagement in movement-based learning (Putri et al., 2021). In the sports context, PjBL might involve students designing training programs, assessing peer performance, or producing instructional content—all aimed at supporting technical and tactical growth.

This study seeks to address the current gap by examining how PjBL can holistically improve student learning outcomes—cognitively, psychomotor-wise, and affectively—in mastering the butterfly stroke during swimming lessons.

## 2. METHODS

### 2.1 Research Design

This study used a quasi-experimental approach in two groups, namely the experimental group and the control group (Babii, 2020). The study looked at how well Project-Based Learning (PjBL) and conventional instruction might raise butterfly stroke learning outcomes. Since participants were pre-assessed to existing classes, practical restrictions in randomly assigning students to various groups led to the choice of this strategy. For the experimental and control groups, the framework consisted of pre- and post-tests (Boncz, 2015). Whereas the control group was taught using traditional demonstration and repetition-based approaches, the experimental group was instructed using a PjBL model.

### 2.2 Participant of the Research

Physical education students registered in a swimming course at Universitas Megarezky during the second semester made up the study's participants. 72 students took part; 36 of them were assigned to

the experimental group and 36 of them to the control group. Because the institutional calendar made random assignment impractical, the grouping was based on pre-existing class assignments.

A pre-test carried out before the intervention guarantees the validity of the group comparisons. Particularly in regard to the butterfly stroke, the results verified that both groups possessed comparable degrees of swimming experience and technical ability. This equivalence guaranteed that any observed variations in post-test results could be ascribed more definitely to the chosen educational strategy than to variations in baseline ability.

### 2.3 Instruments

This study used three kinds of measures to evaluate students' learning outcomes across psychomotor, cognitive, and affective domains to evaluate the efficacy of the instructional strategies. Students' technical proficiency with the butterfly stroke was assessed using the psychomotor assessment rubric. Previously validated, this rubric concentrated on five main components: body posture, arm motion, leg motion, breathing technique, and time. During actual swimming sessions, each component was graded depending on accuracy, consistency, and fluidity of movement. From the evaluation of physical ability, the Cognitive Test was created to gauge students' intellectual grasp of the butterfly stroke. Multiple-choice and short-answer questions covering stroke techniques, swimming rules, and basic biomechanics pertinent to butterfly technique made up this test.

Before the study started, every tool employed was validated for validity and dependability to guarantee the accuracy and consistency of measurement. Three subject-matter experts in physical education and a swimming teaching expert validated the Cognitive Test, and content relevance and clarity guided changes made. Item analysis and a correlation with general test results verified construct validity. Cronbach's alpha was used to evaluate the cognitive instrument's dependability; the coefficient of 0.82 indicated good internal consistency. Reviewed and improved based on expert opinion, the Psychomotor Assessment Rubric—which assessed students' technical performance in the butterfly stroke (including body position, arm motion, leg motion, breathing, and timing) was. Two trained assessors independently scoring a subset of student performances helped to guarantee objectivity by generating an inter-rater agreement coefficient of 0.89 using Cohen's Kappa, therefore implying great dependability. Designed from proven physical education and emotional measurements. The instrument's structure was verified using exploratory factor analysis; Cronbach's alpha came out at 0.85, suggesting great internal consistency and dependability.

### 2.4 Procedure

The purpose of this study was to evaluate how Project-Based Learning (PjBL) affected butterfly stroke learning results of physical education students. The process consisted in several important stages:

- a. At the start of the semester, a pre-test was administered to evaluate students' baseline butterfly stroke-related motivation, knowledge, and ability level. The pre-test included in an affective scale questionnaire, a cognitive exam, and a psychomotor evaluation. Based on class scheduling, 72 students—36 in the experimental group and 36 in the control group—were assigned group projects. Based on the pre-test, both groups started with somewhat equal baseline skill levels. Under Project-Based Learning (PjBL), the experimental group got instruction including group projects, peer evaluation, and instructional films creation. The control group received conventional teaching, combining personal practice with instructor presentations. Following the intervention, a post-test akin to the pre-test was given to gauge improvements in students' psychomotor abilities, cognitive knowledge, and motivation. Two times data were gathered: pre-test and post-test. The

instructional strategies' effect was evaluated using these findings. Using SPSS, the data were examined. Results pre- and post-test were compared using descriptive statistics, paired t-tests (among groups), and independent t-tests (between groups). The results were examined to ascertain how well PjBL improved butterfly stroke students' motivation, knowledge, and ability.

- b. Before the independent and paired sample t-tests, assumptions of homogeneity of variances and normality were examined. The Shapiro-Wilk test revealed that the data for both groups were generally normal ( $p > 0.05$ ). The homogeneity of variances was evaluated using Levene's Test for Equality of Variances; the results ( $p = 170$ ) verified that the presumption was not broken. The Faculty of Education Research Ethics Committee of Universitas Megarezky also approved this work ethically. Before taking part, each subject gave written informed consent and was advised about the nature and goal of the study.

### 2.5 Data Analysis

The two main points of data collection were the pre-test, given before the instructional intervention, and the post-test, done following the intervention time. These tests sought to document variations in student learning results resulting from the chosen teaching strategy. Descriptive statistics—including mean and standard deviation—were used to summarize general performance trends in the scores from the experimental and control groups. Two phases of data collecting—a pre-test before the instructional intervention and a post-test following—were undertaken. IBM SPSS Statistics program will enter and examine the data from the experimental and control groups (Arkkelin, 2014). Starting with descriptive statistics—that is, the mean, standard deviation, minimum, and maximum scores—the study aimed to give a general picture of students' performance in each domain—psychomotor, cognitive, and affective.

Inferential statistical tests were carried out to evaluate the Project-Based Learning (PjBL) model against the conventional teaching approach. The variations between pre-test and post-test scores within every group were examined using a paired samples t-test to see whether the intervention significantly raised or lowered any outcomes. The post-test findings of the experimental and control groups were then compared using an independent samples t-test to see whether the instructional approach produced appreciably different learning outcomes. Every test had an  $\alpha = 0.05$  significance threshold.

## 3. FINDINGS AND DISCUSSION

This section presents the main findings of the study on the application of Project-Based Learning (PjBL) in butterfly swimming learning for physical education students. The results presented include the analysis of pre-test and post-test data on both the experimental and control groups. The analysis was conducted using descriptive and inferential statistics, including paired t-tests and independent t-tests, to determine the effectiveness of PjBL compared to conventional learning approaches.

**Table 1.** Description N-Gain Score

Group	Score	(%)	Category
Experimental	0.56	55.51	Effective
Control	0.22	21.77	No Effective

The notable variations in scores between the two groups show that, in comparison to the control group without treatment, the treatment given to the experimental group improves measurable ability or learning outcomes. Consequently, it may be said that the implemented intervention or technique in the experimental group has shown success in reaching learning goals.

**Table 2.** Tests of Normality

Group		Kolmogorov-Smirnova			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
N-Gain Score (%)	Control	.199	36	.201	.868	36	.242
	Experimental	.199	36	.131	.898	36	.184

a. Lilliefors Significance Correction

The N-Gain Score (%) data in both groups meet the assumption of normality. Therefore, parametric statistical analysis, such as a t-test, can be used to test the differences between groups. All significance values of both methods in each group are greater than 0.05, so it can be concluded that the data are normally distributed. An asterisk (\*) indicates that the Kolmogorov-Smirnov significance value has been adjusted with Lilliefors Significance Correction. Thus, the data in both groups meet the assumption of normality, so further analysis can be done using parametric statistical tests, such as the independent t-test.

**Table 3.** Homogeneity Test

		Levene's Test for Equality of Variances	
		F	Sig.
N-Gain Score (%)	Equal variances assumed	1.921	.170
	Equal variances not assumed		

Table 4 shows that since the significance value is greater than 0.05, the assumption of homogeneity of variance is met, meaning that the variances between the experimental and control groups are equal. Therefore, the t-test results can be used to calculate the equal variances assumed in the analysis of mean differences.

**Table 4.** Independent Samples T-test

		t-test for Equality of Means						
		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
N-Gain Score (%)	Equal variances assumed	8.102	70	.000	10.83333	1.33713	13.50016	8.16651
	Equal variances not assumed	8.102	63.970	.000	10.83333	1.33713	13.50458	8.16208

Based on the table above shows that a very small significance value ( $p < 0.05$ ) indicates that there is a statistically significant difference between the average N-Gain Score (%) of the experimental and control groups. The treatment or intervention applied to the experimental group had a significant impact on improving learning outcomes (N-Gain Score %) compared to the control group that did not receive the treatment.

In the context of physical education, the statistically significant increases in psychomotor, cognitive, and affective outcomes among students taught using Project-Based Learning (PjBL) point to not only effectiveness but also the transforming power of this method. The findings imply that students

who are given responsibility for their education through well-organized, real-world projects participate more fully in the content, work closely with peers, and consider their development more closely. Teachers should thus move from a merely demonstration-practice model to a more student-centered one (Arfenti Amir et al., 2022), an inquiry-based strategy that promotes discovery, decision-making, and teamwork in their instruction (Asdar et al., 2024). PjBL develops a learning environment that reflects real obstacles, thereby assisting children to develop transferable abilities, including critical thinking, problem-solving (Wahyu Muh. Syata et al., 2023), Self-regulation skills are vital for lifetime physical exercise and beyond.

The efficiency of Project-Based Learning (PjBL) in improving physical education students' learning outcomes in mastering the butterfly stroke was explored in this study. Across psychomotor, cognitive, and affective domains, the results unequivocally show that PjBL greatly exceeded conventional training. These results underline the several advantages of including project-based approaches into physical education, especially for teaching technically difficult abilities like the butterfly stroke. The velocity of the butterfly stroke over 50 meters is considerably affected by the strength of the arm muscles, the power of the leg muscles, and the flexibility of the athlete's feet (Faradila NN et al., 2020).

The experimental group demonstrated rather better psychomotor performance. Regarding body position, arm pull, kick, breathing rhythm, and general stroke time, students showed improved coordination. PjBL's active participation, regular practice in real-world settings, and student-generated feedback help to explain this development. PjBL pushed students to become active participants in their learning process (Rusli et al., 2024). Unlike conventional education, where many of them copy the instructor's demonstrations.

PjBL-exposed students scored noticeably better on post-test assessments. This result implies that the approach helped them to better grasp concepts of hydrodynamics, laws, and butterfly stroke techniques. Deeper knowledge processing is supported by PjBL's requirement that students investigate, analyze, and present knowledge in cooperative environments. This is consistent with constructivist theory, which holds that active participation of students in building their knowledge results in meaningful learning (Pande & Bharathi, 2020).

Moreover, the observed affective gains among PjBL group members highlight the advantages of the strategy even more. Students claimed higher degrees of inspiration, fun, and perceived skill. In physical education, where students' emotional involvement and confidence can greatly impact their willingness to practice and grow, these affective elements are crucial. The emphasis on student autonomy, teamwork, and ownership over the learning process by PjBL most certainly helped to produce these affective changes (Aisyah & Novita, 2025).

Interestingly, students in the experimental group frequently considered their learning through group discussions and self-assessment, which was rarely stressed in conventional PE environments. These reflection exercises helped them to assess their approach, create personal goals, and take accountability for their development. PjBL adds this kind of metacognitive development, which improves not only performance but also learning practices (Lee et al., 2014).

The findings of this study coincide with earlier studies stressing the favourable influence of active learning approaches in courses with skill-based orientation. Previous research in sports pedagogy and physical education has indicated that strategies including PjBL, cooperative learning, and inquiry-based learning provide better skill retention and application (Hartanto et al., 2025). For difficult motor skills like the butterfly stroke, these techniques especially give children the required time, feedback, and motivation to improve their motions (Sriningsih et al., 2017).

By contrast, although to a lesser degree, the control group, which received conventional instruction, showed progress. Although practice drills and instructor demonstrations are still crucial, they cannot completely address individual variations in learning pace, comprehension, and confidence. Conventional approaches also often restrict chances for cooperation, introspection, and student-centered research—all of which are essential for learning both the theory and practice of advanced swimming skills.

This study adds to the larger discussion on creative ideas in physical education teaching as well. PjBL fits very nicely with the competences of educational paradigms changing towards 21st-century learning skills, such as critical thinking, teamwork, creativity, and communication. Including project-based activities in physical education courses helps close the distance between more general learning objectives and physical skills, therefore promoting overall student growth (Mashud et al., 2023). Though the study produced favourable results, many constraints had to be admitted. Using intact classes in a quasi-experimental design might restrict generalizability and randomization. Furthermore, the intervention took one semester; hence, long-term skill retention was not assessed.

This study confirms that Project-Based Learning is an effective instructional approach for improving physical education students' technical performance, cognitive understanding, and motivational engagement in swimming, especially in complex strokes like the butterfly. PjBL not only enhances skill acquisition but also promotes meaningful, enjoyable, and student-centred learning experiences (Rusli et al., 2024). On the other hand, the desired learning outcomes were indirectly correlated with graduate competence through the mediating functions of the project-based learning strategy. The project-based learning strategy was found to have a direct and positive relationship with the attainment of graduate competency (Li & Rohayati, 2024). As such, physical education programs should consider adopting PjBL strategies to foster deeper learning and stronger engagement among students.

This study is new in its use of Project-Based Learning (PjBL) to improve learning results in the setting of physical education, more especially in teaching the butterfly stroke, a difficult and physically demanding swimming technique. Although PjBL has been extensively applied in academic fields to foster critical thinking and teamwork, its usage in developing psychomotor skills is still somewhat rare. This study shows especially how PjBL not only enhances technical swimming performance but also deepens conceptual knowledge and increases student motivation.

Furthermore, the study advances the field by providing a thorough evaluation strategy that combines affective, cognitive, and psychomotor domains—a rare practice in physical education research. Concentrating on university-level physical education students in Indonesia also closes a vacuum in the literature by offering localized insights seldom seen in world research. This mix of methodological creativity and contextual relevance makes the study a useful tool for teachers and academics trying to update physical education curricula.

This study had significant limitations. First, it was carried out from a single university with a quite limited sample size, therefore restricting the generalizability of the results. Second, the intervention concentrated just on the butterfly stroke, so findings might not be exactly applicable to other swimming strokes or physical education environments. Third, the study lacked evaluation of long-term retention or skill transfer, even as short-term learning results were recorded. Finally, outside variables were not thoroughly under control, including students' prior swimming experience, physical fitness, and motivation outside the classroom.

#### 4. CONCLUSION

This study concludes that Project-Based Learning (PjBL) is an effective instructional approach for enhancing the psychomotor, cognitive, and affective learning outcomes of physical education students in mastering the butterfly stroke. By encouraging active participation, collaboration, and reflective practice, PjBL leads to improved technical performance, deeper understanding of swimming mechanics, and increased motivation and confidence compared to traditional teaching methods. The model's learner-centered and engaging nature positions it as a valuable pedagogical strategy for teaching complex motor skills in swimming and other sports contexts. However, a key limitation of this research is the lack of investigation into long-term skill retention and the generalizability of findings across different physical activities or educational settings. Future studies should explore the sustained impact of PjBL over time, its adaptability in diverse sports disciplines, and how it performs

in various institutional or cultural contexts. It is also recommended that curriculum developers integrate PjBL into swimming instruction to enhance both conceptual learning and skill acquisition. Teacher training programs should prepare educators to implement PjBL effectively by emphasizing lesson planning, student collaboration, and reflective assessment. Additionally, evaluation strategies should move beyond technical skill assessments to include tools like rubrics, self-reflections, and peer evaluations, ensuring a holistic understanding of student progress across cognitive, psychomotor, and emotional domains.

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