Project-based learning model for volleyball to improve students' cognitive and psychomotor learning outcomes

Modelo de aprendizaje del voleibol basado en proyectos para mejorar los resultados cognitivos y psicomotores de los alumnos

Authors

Aditya Tito Aji Darmawan [1]
Pamuji Sukoco [2]
Agus Susworo Dwi Marhaendro [3]
Ari Septiyanto [4]
Amri Hartanto [5]

[1, 2, 3, 4, 5] Yogyakarta State University (Indonesia)

Corresponding author:
Aditya Tito Aji Darmawan
adityatito.2020@student.uny.ac.id

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Abstract

Introduction: The role of teachers in the learning process is very important to create a conducive atmosphere, therefore teachers are expected to determine the right learning model.
Objective: This study aims to determine the effectiveness of the PjBL-based volleyball learning model on improving students' cognitive and psychomotor learning outcomes.
Methodology: This research is an experiment with a nonequivalent control group design. The sample was taken by simple randomization, namely 82 students as an experimental group with PjBL model treatment and 86 students as a control group with Direct Instruction (DI) treatment. The instrument used cognitive and psychomotor learning achievement tests. Descriptive analysis, data requirement test, and independent sample t test were used to analyze research data.
Discussion: The results showed that the PjBL-based volleyball learning model was effective in improving cognitive aspects and psychomotor aspects in students. The experimental group of the PjBL model is better than the control group, as evidenced in the cognitive aspect t-value 10.137 and p-value 0.000 <0.05, and the psychomotor aspect t-value 6.398 and p-value 0.000 <0.05.
Conclusions: The application of the PjBL learning model in physical education can help to create learning conditions that are more effective, efficient, and fun. Suggestions to students so that they can play a more active role in the learning process, because the teacher-centered learning paradigm has changed to a student-centered learning process, where students are required to be more active in carrying out learning so that the learning process can take place optimally.

Keywords

Project-based learning model, volleyball, cognitive, psychomotor, physical education

Resumen

Introducción: El papel de los profesores en el proceso de aprendizaje es muy importante para crear un ambiente propicio, por lo que se espera que los profesores determinen el modelo de aprendizaje adecuado.
Objetivo: Este estudio pretende determinar la eficacia del modelo de aprendizaje del voleibol basado en el PjBL en la mejora de los resultados cognitivos y psicomotores del aprendizaje de los alumnos.
Metodología: Esta investigación es un experimento con un diseño de grupo control no equivalente. La muestra se tomó por aleatorización simple, a saber, 82 estudiantes como grupo experimental con tratamiento del modelo PjBL y 86 estudiantes como grupo de control con tratamiento de Instrucción Directa (DI). El instrumento utilizado fueron pruebas cognitivas y psicomotoras de rendimiento en el aprendizaje. Para analizar los datos de la investigación se utilizó el análisis descriptivo, la prueba de exigencia de datos y la prueba t de muestras independientes.
Discusión: Los resultados mostraron que el modelo de aprendizaje de voleibol basado en el PjBL fue eficaz para mejorar los aspectos cognitivos y los aspectos psicomotores en los estudiantes. El grupo experimental del modelo PjBL es mejor que el grupo de control, como se evidencia en el aspecto cognitivo t-valor 10,137 y p-valor 0,000 <0,05, y el aspecto psicomotor t-valor 6,398 y p-valor 0,000 <0,05.
Conclusiones: La aplicación del modelo de aprendizaje PjBL en educación física puede ayudar a crear unas condiciones de aprendizaje más eficaces, eficientes y agradables. Sugerencias a los alumnos para que desempeñen un papel más activo en el proceso de aprendizaje.

Palabras clave

Modelo de aprendizaje basado en proyectos, voleibol, cognitivo, psicomotor, educación física.

Introduction

Volleyball is one of the materials in Physical Education (PE), especially at the upper secondary education unit level (Dewanti, Nompembri, Hartanto, & Arianto, 2023; Risma, Dlis, & Samsudin, 2020). The basic competencies of the knowledge aspect that must be possessed are that students understand specific movements in various volleyball games and the skill aspect of practicing specific movements in volleyball games (Priyadi, 2021). These indicators must get the attention of Physical Education teachers so that all basic competencies and learning objectives in volleyball games can be achieved by students (Sujarwo, Suharjana, Rachman, & Al Ardha, 2021).

Indicators of learning success can be realized properly supported by the creativity of the teacher himself in choosing the right learning model (Supena, Darmuki, & Hariyadi, 2021). In the process of learning, it is insufficient for teachers to possess only subject-specific knowledge; they must also focus on various learning facets that contribute to fostering the holistic development of students' potential (Tanri et al., 2023). To achieve favorable outcomes in physical education, teachers in this field should strive to enhance the quality of instruction, engaging a wide range of students in the learning process (Aziz et al., 2023).

The enhancement of student learning outcomes can be achieved through the implementation of an effective and efficient learning model across various subjects, including physical education (Iserbyt, Ward, & Li, 2017). A recurring issue in physical education instruction is the persistence of conventional teaching methods (Vanluyten et al., 2023). This is evident in the classical and large-group settings where the learning process takes place without considering the individual characteristics of the students. The teacher's role remains predominant, with full authority in organizing and dictating the learning process, hindering students from developing their critical thinking skills (Yulianti et al., 2024).

The learning that is expected to be able to overcome these problems is through the Project-Based Learning (PjBL) learning model (Sepúlveda, Torres, Roco, & Crichton, 2024) which is supported by constructivistic theory which rests on the idea that learners build their own knowledge in the context of their own experiences (Ningsih, Ahman, & Riswanto, 2020). The PjBL teaching model is a teaching pattern that educates students to obtain learning objectives by being directly involved in the stages of learning by working on scheduled and controlled tasks in the form of completing teaching products (Coyne, Hollas, & Potter, 2016). This means that PjBL is not learning what is told and fixated on procedures and instructions from the teacher, so that the active role of teaching shifts from the teacher to the student. The teacher only acts as a facilitator and motivator in the learning process (Sigit, Ristanto, & Mufida, 2022).

While working on project implementation, learners will have the opportunity to develop various important skills and abilities (Gallego, Linares, & Benjumea, 2024). The goal is to acquire the ability and cognitive skills to solve problems rationally, straight forwardly, and thoroughly. Therefore, learners not only understand concepts relevant to the problem at hand but also gain learning experiences related to the skills of applying scientific methods in problem solving and fostering critical thinking patterns (Efendi, Sumarmi, & Utomo, 2020).

The cognitive and psychomotor learning outcomes of students taught with the PjBL model are greater than the average of students who learn with the blended learning model(Umar et al., 2023). Findings from Mashud et al., (2023) study showed that teaching using PjBL and inclusive teaching models and teaching using traditional methods had a positive effect and could improve students' freestyle swimming ability ($p < 0.05$). The experimental group taught using the integration of PjBL and inclusive teaching models appeared to have higher learning outcomes. This research is different from previous research, comparing PjBL and inclusive learning models in swimming learning (Mashud et al., 2023), then knowing the difference between blended learning and PjBL on cognitive and psychomotor abilities (Umar et al., 2023). This study will determine the effectiveness of the PjBL learning model integrated with volleyball sports on improving students' cognitive and psychomotor learning outcomes.

The urgency of this research is that students are less active in the learning process of Physical Education volleyball material, and cognitive and psychomotor learning outcomes are still low. Teachers in learning still use traditional learning methods, so the right learning model is needed, especially in

learning physical education volleyball material. Volleyball learning is possible to use the PjBL model, because the PjBL model can improve psychomotor skills and understanding of concepts and train various thinking skills, and attitudes where learning involves the activeness of students in solving problems (Fadilah, Maryono, & Wihidayat, 2019). PjBL can be packaged in the form of games to test the relationship between cognitive, affective, and motor intelligence (Aliriad, Soegiyanto, Setijono, & Sulaiman, 2023). PjBL offers a unique approach to volleyball teaching, which encourages critical thinking, collaboration and problem-solving skills. By combining real-world scenarios and authentic assessment, teachers can create engaging and effective learning experiences (Simonton, Layne, & Irwin, 2021).

Erwin (2017) suggested that the field of PE needs to consider embracing this innovation and incorporate PBL in the PE classroom. Recently, Treadwell (2018) suggested that Science, Technology, Engineering, Arts, and Math (STEAM), Comprehensive School Physical Activity Programs (CSPAP), and PjBL are interrelated and provide an ideal holistic learning opportunity for PE students. However, there is limited exploration and research into PjBLs effect on student experiences in PE or, in general, as an innovative model within K-12 PE (Coyne et al., 2016; Hastie, Chen, & Guarino, 2017).

Treadwell (2018) suggests that in the changing world of education policy that PE teachers can contribute a major role to schools whose initiatives include adopting STEAM and/or CSPAP. Given how closely related many PjBLs characteristics are to other evidence-based PE instructional models, adopting the PjBL model may be comparable and potentially more plausible given the entire schools incentive to offer proper training, as opposed to specialized training/development only for PE or vice versa. For example, point out, innovative PE models like Sport Education, Tactical Games Model (TGM), and Teacher Personal and Social Responsibility Model (TPSR) are all considered student-centered instructional strategies that provide autonomy-supportive environments and prioritize all three learning domains as opposed to simply getting students physically active (Casey, 2014; Ennis, 2015). However, teachers offering these models may not receive enough professional development support and teachers who experience one-off trainings are less likely to adopt change. As importantly, PE teachers housed in schools that prioritize STEAM may demonstrate their academic importance and vital role of PE in students' holistic learning experiences by adopting PBL as well (Treadwell, 2018).

Teachers must adopt new classroom management skills and learn how best to support learners in learning, use technology where necessary and must believe that learners are fully capable of learning through the PjBL approach (Condliffe, 2017). Physical Education teachers are expected to improve the quality of learning both in the classroom and in the field and the effectiveness of learning models (Casey & MacPhail, 2018). Teachers prepare learning models properly and appropriately so that students find it easier to build their own understanding (Wu & Wu, 2020; Yamin, Halim, & Muhayyang, 2023). This model focuses on learner-centred learning by completing tasks collaboratively in small groups. The given and arranged learning tasks, in such a way, use open-ended questions to create the requirement to answer inquiries while developing fundamental abilities through realworld contexts that encourage students to learn to solve problems and be more creative (Juniar, Suherman, Tarigan, & Mahendra, 2023).

Project-based learning focuses on active and interaction-based learning among students, thus encouraging students to collaborate or work together in groups or teams to solve problems and achieve common goals (Ramírez et al., 2017), placing students as the main focus of learning to be actively involved in the learning process and teachers as facilitators or guides (Lozano, López, Pereira, & Blanco Fontao, 2022; Yusof et al., 2022), providing opportunities to interact, communicate, negotiate, and cooperate among students or with others (Cañabate et al., 2021), providing contextualized learning where students learn to apply the knowledge and skills learned to situations relevant to real life (Lozano et al., 2022), and focusing on measurable outcomes, where students are expected to produce products or performances that demonstrate understanding of the topic being studied and the ability to complete the given task (Luo, Lin, Hsu, Liao, & Kao, 2020).

The PjBL learning model is considered appropriate in overcoming the problems that have been stated previously, especially in accordance with the independent curriculum that is being used by the Indonesian education system. Based on this background, this study aims to determine the effectiveness of the PjBL-based volleyball learning model to improve students' cognitive and psychomotor learning

outcomes. Where we hypothesize that the PjBL-based volleyball learning model is better than the control group on improving students' cognitive and psychomotor learning outcomes.

Method

Participants

The subjects in this study were students of Vocational High Schools in Yogyakarta, namely Vocational High School 1 Depok Sleman and Vocational High School 2 Yogyakarta. Simple random sample selection, obtained Vocational High School 1 Depok Sleman totaling 82 students (average age 16-19 years, male 52, female 30) as the experimental group with PjBL model treatment and Vocational High School 2 Yogyakarta totaling 86 students (average age 16-19 years, male 59, female 27) as the control group with Direct Instruction (DI) treatment. Information about the study was explained to the students; the purpose, data collection steps, timing of the study, and benefits of participation in the research project were provided to the students. All respondents were asked to provide written informed consent before participating in the study.

Research Design

This study used a quasi-experiment research design with an experimental group and a control group. Data on learning outcomes of basic volleyball lower passing techniques were collected through practical tests conducted before and after the learning intervention. These practical tests included aspects of volleyball technique and cognitive tests using multiple choice tests, and were analyzed using appropriate statistical tests. In addition, this study also involved observing the interaction between students in the experimental group during the learning process.

The experimental group was given a learning treatment using the integration of project-based learning. The following are the stages of the procedure used in this study: (1) diagnostic assessment, (2) determining goals and designing product plans, (3) designing a variety of learning material difficulties, (4) arranging product making schedules, (5) practicing and monitoring project development, (6) feedback on the teaching process, and (7) evaluation of learning experiences (Faozi, Fatekurohman, Aini, & Yuniar, 2020). The steps of the project-based learning (PJBL) model in volleyball are: (1) Searching and observing information about variations and combinations of basic techniques of volleyball games. (2) Asking questions, for example by asking questions with the teacher about the lower passing material. (3) Trying, for example by forming groups and practicing lower passing. (4) Analyzing, for example by analyzing the activities carried out in each group. (4) Communicating, for example by practicing the ability to pass down in the middle of the field.

The implementation of the research was carried out for 8 weeks, with details, meetings 1-2: introduction to pjbl and learning topics, meetings 3-4: learning basic concepts and project planning, meetings 5-6: project implementation and guidance, meeting 7: project evaluation and revision, meeting 8: presentation of results and reflection.

The control group was taught by using the traditional learning method that has been used in teaching so far, namely Direct Instruction (DI). The teaching by using the DI model was carried out by following the teaching syntax including (1) conveying goals and motivating students, (2) demonstrating knowledge and skills, (3) guiding exercises, (4) checking understanding and feedback, and (5) continuing the teaching (Sukardjo & Salam, 2020). The control group in this study will receive conventional learning (lecture, discussion), follow standard learning procedures, receive the same learning materials as the experimental group, and be measured and evaluated with the same instruments as the experimental group.

We used observation sheets to record the course of research in the field. At the end of the study, researchers managed the cognitive and psychomotor learning achievement test data collected with the volleyball lower passing skill test observation sheet to determine the success rate of the learning model used in the study. The research procedure began by first conducting a Focused Group Discussion (FGD) and was carried out on the basis of consideration to determine the validity and reliability of the instrument. Researchers conducted one FGD with six expert lecturers. Furthermore, the research ana-

lyzed the validity using Aiken's validity, the result was 0.92, while the reliability used the Intraclass Correlation Coefficient of 0.824.

Data analysis

The research data analysis in this study used the descriptive analysis (mean, standard deviation, minimum value, and maximum value). In addition, to find out whether or not there is an effect of the model being tested, we used the analysis of the independent test (t-test). Before the t-test analysis was carried out, we conducted an analysis of the assumption test, namely the homogeneity test and the normality test. The significance value used is 0.05. All of these analyses were assisted by the IBM SPSS program version 21.

Results

The results of the descriptive analysis of the pretest-posttest cognitive aspects and psychomotor aspects of the PjBL model experimental group and the control group are presented in Table 1.

Table 1. Descriptive statistics

Group	Aspect	Data	N	Mean	Std. Deviation
Experiment (PjBL)	Cognitive Aspect	Pretest	82	56.99	8.46
		Posttest		77.80	10.94
	Psychomotor Aspect	Pretest		61.59	8.22
		Posttest		72.03	5.58
Control (DI)	Cognitive Aspect	Pretest	86	57.05	9.01
		Posttest		62.09	9.10
	Psychomotor Aspect	Pretest		61.77	7.87
		Posttest		64.97	8.37

Figure 1. Cognitive Aspect Group Experiment (PjBL) and Control (DI)

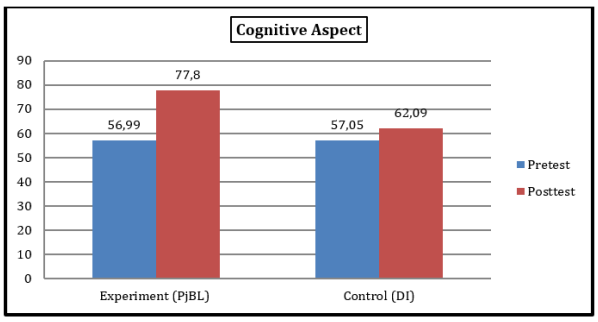
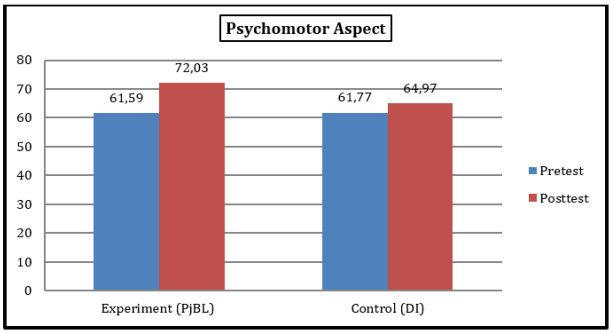


Figure 2. Psychomotor Aspect Group Experiment (PjBL) and Control (DI)



Based on Table 1, obtained data from the PjBL experimental group, cognitive aspects (pretest 56.99 ± 8.46, posttest 77.80 ± 10.94) and psychomotor aspects (pretest 61.59 ± 8.22, posttest 72.03 ± 5.58), while the control group, cognitive aspects (pretest 57.05 ± 9.01, posttest 62.09 ± 9.10) and psychomotor aspects (pretest 61.77 ± 7.87, posttest 64.97 ± 8.37).

Normality Test

The normality test uses the Shapiro-Wilk test, namely by looking at the Asymp. Sig (2-tailed) residual variable if the value is above 0.05, it can be said that the data is normally distributed. A summary of the normality test results is presented in Table 2.

Table 2. Normality test analysis results

Group	Aspect	Data	N	Mean
Experiment (PjBL)	Cognitive Aspect	Pretest	82	0.100
		Posttest		0.118
	Psychomotor Aspect	Pretest		0.097
		Posttest		0.129
Control (DI)	Cognitive Aspect	Pretest	86	0.125
		Posttest		0.187
	Psychomotor Aspect	Pretest		0.171
		Posttest		0.182

Based on the results in Table 2 shows that the PjBL experimental group data, cognitive aspects (pre-test p-value 0.100>0.05, posttest p-value 0.118>0.05) and psychomotor aspects (pretest p-value 0.097>0.05, posttest p-value 0.129>0.05), while the control group, cognitive aspects (pretest p-value 0.125>0.05, posttest p-value 0.187>0.05) and psychomotor aspects (pretest p-value 0.171>0.05, post-test p-value 0.182>0.05), which means the data is normally distributed.

Homogeneity Test

The homogeneity test is useful to check the homogeneity of a sample. A homogeneous or heterogeneous sample drawn from a population. Univariate test with Levenes test. A test is declared unimodal if the univariate rule p-value > 005. Similar test results are shown in Table 3.

Table 3. Homogeneity test analysis results

Aspect	Data	Mean
Experiment (PjBL)	Pretest-Posttest Cognitive Aspect	0.146
	Pretest-Posttest Psychomotor Aspect	0.238
Control (DI)	Pretest-Posttest Cognitive Aspect	0.321
	Pretest-Posttest Psychomotor Aspect	0.194

Based on statistical analysis of homogeneity tests that have been carried out using the Levene Test in Table 3. The calculation results obtained by the PjBL experimental group (cognitive p-value 0.146 > 0.05, psychomotor p-value 0.238 > 0.05), while the control group, (cognitive p-value 0.321 > 0.05, psychomotor p-value 0.194 > 0.05). This means that the data groups have homogeneous variants. Thus the population has the same variant or homogeneous.

Hypothesis Test Results

The hypothesis in this study was tested using t test analysis, namely independent sample t test using the help of Statistical Package for Social Science (SPSS) version 21 software. Based on the results of the analysis obtained data in Table 4.

Table 4. Normality test analysis results

Aspect	Group	t	Sig.	95% Confidence Interval of the Difference	
				Lower	Upper
Experiment (PjBL)	Experiment (PjBL) Control (DI)	10.137	0.000	12.652	18.772
Control (DI)	Experiment (PjBL) Control (DI)	6.398	0.000	4.879	9.234

Based on the results of the independent sample t test analysis in Table 4, it shows that:

Cognitive variables obtained t-value 10.137 and p-value 0.000 <0.05, then there is a significant difference in cognitive aspects in the experimental group of PjBL model and control group. The difference in cognitive aspects in the PjBL model experimental group and the control group was 15.71, meaning that the improvement in cognitive aspects in the PjBL model experimental group was better than the control group.

The psychomotor variable obtained a t-value of 6.398 and a p-value of 0.000 <0.05, indicating that there is a significant difference in psychomotor aspects in the PjBL model experimental group and the control group. The difference in psychomotor aspects in the PjBL model experimental group and the control group is 7.06, meaning that the improvement in psychomotor aspects in the PjBL model experimental group is better than the control group.

Discussion

The results of our research show that the cognitive and psychomotor learning outcomes of the PjBL model experimental group are better than the control group. In the experimental group of the PjBL model, students seemed to understand the concept better, were more active, independent and creative in compiling problem solving steps and solving problems both individually and in groups. The PjBL approach can help students understand things more deeply and creatively than traditional classroom based learning. Student creativity increases after utilizing PjBL by showing innovative ideas, trying their best to come up with fresh ideas for excellent projects, and students actively participating in the learning process (Chen, Lai, Lai, & Su, 2022). To achieve the desired goals, the project scope, resources, and planning activities are used to implement and manage the resources. It is possible to comprehend the project's scope, simulate real-world challenges, develop concepts and creativity, cultivate interpersonal skills, assess actual knowledge, choose real-world scenarios, and assess student abilities (Bellas, Guerreiro-Santalla, Naya, & Duro, 2023).

The increase experienced in the control group was not as high as the increase in psychomotor abilities in the intervention group. This is because the PjBL learning applied in the experimental class encouraged students to be active in the learning process (Shin, 2018). Students are formed in several groups so that they can communicate with each other regarding the ideas discussed during learning. Students are encouraged to be able to solve project design problems given in groups and students are encouraged to be more active in exploring sources of information from anywhere. In addition, students are also required to think as creatively as possible because the projects given to each group have no limits on design, answer details, and various other creativity. PjBL teaches individuals to develop the ability to analyze cognitive abilities which are shown by changes in affective abilities and psychomotor skills (Nasir, Fakhrunnisa, & Nastiti, 2019).

The Project-based Learning (PjBL) model is a model that exposes students to relevant learning, which positively influences the development of students' creative thinking, allowing students to actively explore knowledge, ask questions, find problems, design, and implement projects (Azzahra, Arsih, & Alberida, 2023). The project-based learning strategy has better potential in improving students' metacognitive abilities compared to conventional learning strategies with a score difference between pretest and posttest scores of 22.73 (Rumahlatu & Sangur, 2019). This present study has shown that the PjBL STEM model can improve students' cognitive learning outcomes in science learning for Indonesian fifthgraders. This increase is evidenced by consistent improvement in Cycle I and II with 82.5% and 92.5%, respectively. Most students also scored above the minimum index of completeness criteria and showed learning enthusiasm as observed by the researchers (Lestari, Ambarwati, & Asih, 2024).

PjBL is an approach that prioritizes students to be able to solve problems that are actually encountered in the field. In this learning, students will play the role of a professional who tries to solve problems in everyday life (Boss & Krauss, 2022). PjBL is a learning process whose starting point is based on real-life problems and then from this problem students are stimulated to study this problem based on the knowledge and experience they have previously had (prior knowledge) so that from this prior knowledge new knowledge and experience will be formed (Gunawan, Sahidu, Harjono, & Suranti, 2017).

It focuses on the core concepts and principles of a discipline, engages students in problem-solving investigations and other meaningful tasks, allows students to work autonomously to construct their own knowledge, and culminates in a real product (Žerovnik & Nančovska Šerbec, 2021). The advantages of project-based learning model are able to increase students' motivation, problem-solving ability and cooperation attitude, and resource management skills. The PjBL process can make it easier for students to understand the material, because students directly apply their knowledge into a project that they arrange (Sahtoni, Suyatna, & Manurung, 2017). The project will make it easier for students to remember the concepts that have been obtained. PjBL is one of the learning alternatives that can be used not only to assess cognitive aspects, but also student performance (Guo, Saab, Post, & Admiraal, 2020).

Implementation of the PjBL model can further improve learning outcomes and critical thinking of students (Garnjost & Brown, 2018). The advantages of the PjBL method are that it can encourage students to develop and practice communication skills, improve existing resource management skills and can provide students with experience in organizing a project to solve problems. Positive experiences in terms of developing employability skills, such as teamwork, project management and professional skills as well as the satisfaction of good output from the project and the interest of students using the PjBL learning method (Vesikivi, Lakkala, Holvikivi, & Muukkonen, 2020).

Learning through project work in the form of student-centered teaching aids is significant and beneficial to students' cognitive, emotional, and psychomotor development, which supports the findings of this study (Balasubramani, Aamer, & Sonawane, 2020). By allowing students to apply what they have learned in real-world situations, practical work helps students understand lessons, improve psychomotor skills and dexterity. These exercises can teach students skills such as observing, measuring, classifying, documenting data, generating, changing, controlling variables, and conducting scientific experiments, to name a few. Cognitive learning success is related to one's intellectual ability. Students' affective and psychomotor abilities are closely related to cognitive learning abilities. This is because the cognitive, emotional, and psychomotor domains are all related to learning behavior (Enoch, Abraham, & Singaram, 2022). Students who excel in cognitive learning can improve their affective and psychomotor domains (Mallillin, 2020).

Incorporating PjBL may provide greater potential for cross-curricular integration, which can help achieve school wide goals. Similar steps with PE-focused models like the Sport Education model (Siedentop, Hastie, & Van der Mars, 2019) and the Science, PE, and Me! curriculum (Ennis, 2015) have attempted similar methods by including science, math, and history topics in a variety of PE units. PBL may help in reducing boundaries including removing traditional thoughts about what PE used to be to, what PE can provide current and future students. Using PBL is likely to incorporate multiple school subjects (e.g., math, science, technology) into PE, expanding PE's relevance (Coyne et al., 2016). Cross-curriculum integration in this format might provide a sense of connectedness between PE topics and everyday life, as opposed to seeing PE in a school-only silo, unconnected to life. The interpretation of the PE curriculum is quite broad (Dyson & Casey, 2012), suggestion PBL techniques have the flexibility to meet unique student needs.

Researchers Ramírez et al., (2017) reported pre/post intervention design which consisted of three consecutive PBL units across the school year. Although limited information on the PBL steps were provided, researchers reported use of student-centered, productive teaching styles. Students worked in small groups to solve content problems and had to present solutions via game/activity knowledge. Students were also expected to keep journals and conduct homework. Semi-structured interviews showed that students reported positively to having more accountability and ownership in the learning process. Students reported higher scores in perceived responsibility, effort, and self-worth following the units. Teachers reported positive outcomes and stated their students took leadership and developed more respect when they oversaw equipment and their own projects. They felt PBL was more effective in teaching personal development values and skills than traditional methods. Lastly, teachers lamented that planning was difficult and took more time and managing students at different stages in the unit was challenging. However, teachers recognized that student's self-worth progressed positively across the school year. Ramírez et al., (2017) note that PBL disrupts traditionally teaching beliefs and habits which causes teachers to weigh the risks and question themselves which may make them less

prone to adoption in some ways. Thus, more evaluation on PBLs impact and implementation in PE in needed.

Although we have tried to investigate in depth, this study has limitations. Firstly, since the research participants were already programmed in the class, individual randomization was not possible and the study only conducted group or class randomization. In experimental research, randomized individuals are a strength to minimize bias or threats to internal validity. Secondly, this study did not analyze in detail the relationship between male and female participants. In fact, physiologically and motorically there are differences in abilities between men and women. Third, this study did not consider the psychological aspects of the participants involved in the study. In fact, aspects of anxiety, mental aspects and aspects of religiosity and happiness are very likely to play a role in determining learning outcomes. Based on these limitations, we recommend that future research should randomize individuals, taking into account the gender and psychological aspects of the research participants.

It is suggested that future research needs to expand the instrument used, not only for students but also for teachers and parents so that the information obtained will be more objective and robust. Future research can also select elementary and junior high school student populations so that empirical data on the effect of project based learning model will be more substantial. Researchers should consider findings in other subject areas regarding model fidelity and practice while incorporating PE-focused outcomes (Hastie et al., 2017). If PjBL can produce student's with applicable skills for the real world, it's effective use in physical education provides a strong argument for PE's relevance to the greater academic community.

The limitations of PjBL in Physical Education are (1) Time required: PjBL requires more time than traditional learning methods. (2) Teacher skills: Teachers must have the ability to design and implement effective PjBL. Recommendations to Overcome Limitations, namely (1) Teacher training: Provide training for teachers to improve their ability to design and implement PjBL. (2) Use of technology: Utilize technology to support PjBL, such as simulations and educational games. (3) Collaboration with experts: Collaborate with sport experts to improve the quality of PjBL. (5) Integration with the curriculum: Ensure PjBL is integrated with the curriculum and educational standards.

Conclusions

The results showed that the PjBL-based volleyball learning model was effective in improving cognitive aspects and psychomotor aspects in students. The experimental group of the PjBL model is better than the control group, as evidenced in the cognitive aspect t-value 10.137 and p-value 0.000 <0.05, and the psychomotor aspect t-value 6.398 and p-value 0.000 <0.05. The application of the PjBL learning model in physical education can help to create learning conditions that are more effective, efficient, and fun. Suggestions to students so that they can play a more active role in the learning process, because the teacher-centered learning paradigm has changed to a student-centered learning process, where students are required to be more active in carrying out learning so that the learning process can take place optimally. PjBL can be a learning innovation that can bring up creative and critical ideas and solutions, making it easier to solve a problem. Therefore, it is highly recommended for educators to use the PjBL learning model as an innovative learning model in schools.

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Conflict of interest

We are not aware of any conflict of interest related to this publication. Also no financial aspects were included in this study which might have affected the results. On behalf of the corresponding author I approve the manuscript for reading and submission by all named authors.

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Authors' and translators' details:

Aditya Tito Aji Darmawan	adityatito.2020@student.uny.ac.id	Author
Pamuji Sukoco	pamuji_sukoco@uny.ac.id	Author
Agus Susworo Dwi Marhaendro	agus_marhaendro@uny.ac.id	Author
Ari Septiyanto	ariseptiyanto@uny.ac.id	Translator