

## Article

# Analysis of the Problem-Based Learning Model's Application for the Sustainable Development of Sports Education

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**Abstract:** The purpose of this study was to analyze importance and performance levels by applying the problem-based learning (PBL) education model for the sustainable development of sports education. In this study, 331 university sports majors who received PBL education at least once were administered a questionnaire from 15 July to 20 September 2022. Frequency analysis (using SPSS 25.0), exploratory factor analysis, reliability analysis, descriptive statistical analysis, and IPA were used for data processing. The results are as follows: The first quadrant of the IPA matrix comprised attributes such as determining the cause of the problem, acquiring sufficient knowledge through learning, gathering information related to the problem, getting to the heart of the matter, and building intimacy among team members. The second quadrant included planning for oneself when learning, considering the importance of self-learning, and actively answering questions. The third quadrant included enthusiasm and sincerity toward team learning. The fourth quadrant included 11 attributes: proper planning and execution, understanding others' points of view, the joy of team learning, prioritizing problem-solving methods, creative communication, communication with team members, proactive communication, everyone on the team working hard, feeling a sense of accomplishment, a sense of challenge, and an increase in self-confidence.

**Keywords:** PBL; education model; application; sports education; sports major



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## 1. Introduction

Universities are increasingly striving to provide creative education to students. Recently, as traditional academic fields have been integrated and grafted into various majors suitable for the new era, university education has moved away from one-sided lectures to enable various forms of learning to improve its effectiveness. One of these forms includes problem-based learning (PBL), which many universities have adopted as part of their efforts to foster the sustainable development of sports education [1]. Several universities are attempting to supplement educational methods from theoretical to practical and from propositional knowledge to methodological knowledge [2]. Among the various teaching and learning methods, the PBL is a university teaching method that produces specific results by conducting long-term projects [3]. This learner-centered model emphasizes the problem-solving process through a learner-led initiative. Despite some differences, previous research shows that PBL was introduced to solve practical problems in American medical schools [4] and is known as a learner-centered self-directed learning method based on the constructive learning theory [5].

Recently, several scholars have raised the need for providing PBL education for sports majors who study sports practice guidance and theory. This is because through PBL, students can gain a practical experience of creatively solving real-world problems in various fields of sports education, rather than merely studying them as classroom topics [6]. Second, in addition to contributing toward problem-solving in sports companies or clubs, the solutions derived by sports majors in their PBL classes can be directly applied to the field, thereby facilitating organic links between universities and sports sites [7]. Third, PBL

fosters active interactions between learners and professors because the project is conducted by forming a project team in an autonomous classroom environment. Fourth, as PBL projects are typically structured as team projects, sports majors can develop communication, problem solving, and self-directed learning skills that they previously lacked [8]. Thus, providing fresh experiences to sports majors and identifying in detail the direction that the PBL education model should pursue based on the learners' current experiences is crucial for the sustainable development of universities providing sports education.

In addition to the strengths of the PBL teaching method, research is being conducted on various aspects of PBL in various academic fields to reflect expectations regarding future talent development in the era of the Fourth Industrial Revolution [9,10]. Previous studies have shown that PBL classes improved students' problem-solving [11,12], communication [13,14], and self-directed learning [15,16] abilities, which are the ultimate educational goals of the PBL model. Although these studies have confirmed the effectiveness of the PBL education model [17], they focused only on the effectiveness of this model and lacked an academic approach to understanding learner's expectations and areas of improvement, thereby warranting further research. Therefore, there is a need to closely understand the type of curriculum that should be implemented for teaching sports majors attending universities that follows the PBL education model [18].

The Importance–Performance Analysis (IPA) used in this study simultaneously evaluates what is considered important and to what extent it has been implemented, based on the personal experiences of PBL sports majors. In addition, it is used in research focused on improving the quality of various educational services, as it can help identify the priorities and develop plans to improve the efficiency of educational methods [19]. Therefore, it is a suitable method for determining potential priorities in this study [20,21], which aims to evaluate the importance and execution level of the PBL education model to obtain useful information for prioritizing improvement areas in the IPA matrix.

The objectives of this study are as follows: First, the PBL education model is compared and analyzed simultaneously using IPA to determine which attributes sports majors consider important and how they are implemented. Second, the four areas of “keep up the good work”, “concentrate here”, “low priority”, and “possible overkill” were effectively analyzed through the matrix to determine the direction that the PBL education model should pursue. The significance of this study is that it provides materials that can be applied to the field as an educational curriculum to achieve sustainable development of the PBL education model that universities are currently pursuing.

### *1.1. PBL Education Model*

PBL is an educational model in which learners develop knowledge and skills while solving real problems or tasks [22]. The PBL curriculum aims to foster consistent talents equipped with problem-solving capabilities that reflect future social demand and consists of the following procedures [4]. First, presenting a problem: presenting a problem or scenario that occurs in a company, industry, or community. Second, team composition: students form teams and divide their roles among team members. Third, problem analysis: students analyze and understand the given problems and search for the necessary information and skills. Fourth, derivation of solutions: deriving solutions to problems through discussion and investigation. PBL has become established as a new educational model in the era of the Fourth Industrial Revolution as it enables students to solve practical problems that arise in the field through linkages between industry and universities [23].

### *1.2. IPA*

IPA is an evaluation technique that simultaneously compares and analyzes the relative importance and performance of each attribute [24]. Martilla and James' study was the first to apply the IPA model to limit management diagnostic techniques based on consumer opinion surveys in the automobile business [25]. In addition, the IPA has been used to evaluate education services and service quality improvement [26,27], an educational

model's efficacy [28], and the quality of learners' education [29]. In this study, the IPA helped derive priority items that require quick and easy improvement through the matrix of the PBL attributes that sports majors value and their post-learning performance [30]. The IPA matrix in Figure 1 consists of four quadrants, with the  $x$ -axis representing the performance attribute and the  $y$ -axis representing the importance attribute. Specifically, these include: "keep up the good work" (QI: A state in which learners recognize an attribute as important and high performing), "concentrate here" (QII: A state in which an attribute's importance is recognized, but the level of execution is not good), "possible overkill" (QIII: A state in which the attribute is unimportant and poorly executed), and "low priority" (QIV: A state in which the attribute is not important, but well executed) [31].

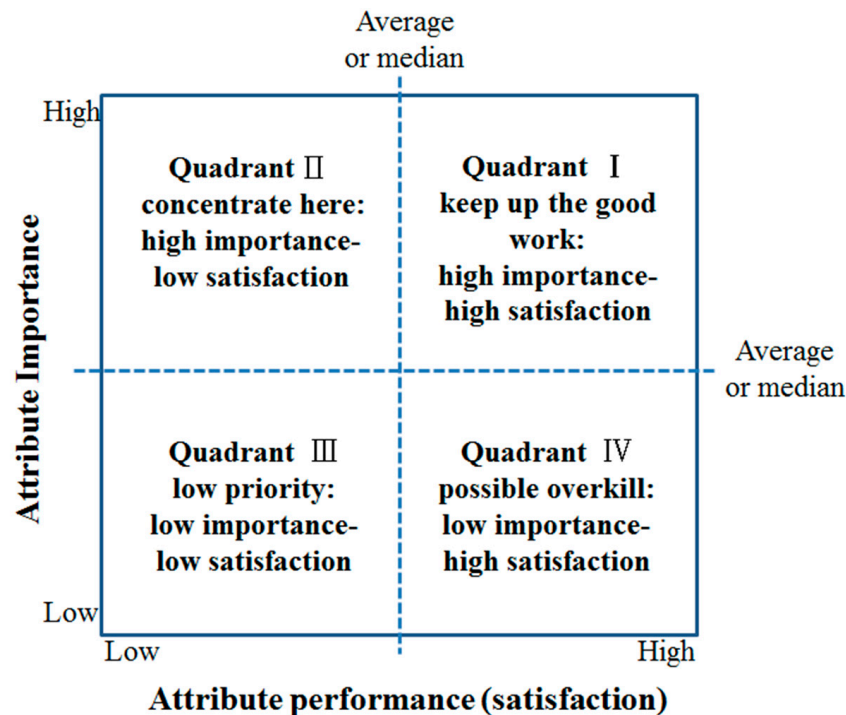


Figure 1. Importance–Performance Analysis (IPA) matrix.

## 2. Methods

### 2.1. Participants and Procedure

This study was conducted in accordance with the principles of the Declaration of Helsinki and of the Research Ethics Committee from Hanyang University (IRB-HYUC-2023-158). University sports majors who had received PBL education at least once were selected as study subjects. From the nonprobability sampling methods, the judgment sampling method was used to extract the samples. In this method, the researcher selects a sample of members judged suitable for the purpose of the study [32]. A total of 350 questionnaires were distributed for approximately two months, from 15 July to 20 September 2022. The order of distribution and collection of the questionnaires was as follows: First, three master's degree researchers with extensive survey experience visited the Sports Science Department of Hanyang University (which has required a mandatory completion of PBL courses since 2017), which has shown some success in applying the PBL education model. Second, the purpose of the study was fully explained and the participants' informed consent and cooperation was obtained. They were then asked to complete a self-administered questionnaire. Of the collected questionnaires, 19 were rejected because of double entries, inconsistent scores, and omission of answers. Thus, 331 questionnaires were finally selected as valid. The demographic characteristics of the study participants are shown in Table 1.

**Table 1.** Demographic characteristics.

	Division	Frequency	Ratio (%)
Gender	Male	281	84.9
	Female	50	15.1
Grade	2nd grade	113	34.1
	3rd grade	152	46.0
	4th grade	66	19.9
Major	Natural science	183	55.3
	Humanities and social science	148	44.7
	Total	331	100

## 2.2. Measurement

This study used the questionnaire, a quantitative approach method for data collection; all items and variables were constructed based on theories and previous studies that fit the purpose of the study. The questionnaire consisted of three parts: demographic characteristics, three open-ended questions, and questions on the importance and performance of communication, problem solving, self-directed learning, team learning, and confidence and sense of achievement, which are the ultimate goals of the PBL education model. It consisted of 43 questions, with 20 questions in each of the execution diagrams. Specifically, the questionnaire was prepared by referring to a study on communication in a new curriculum [14], to compare the average values of the importance and execution of the PBL education model and the contents of previous studies' questionnaires, which measured the application of project and problem-based classes [8,9]. The questionnaire then underwent a modification and supplementation process. In addition, the content validity of the questionnaire was confirmed by a panel of two PBL education experts, especially for items that could not be derived from previous studies or major questions that needed to be newly created. The final items were selected through a series of selection and deletion processes conducted over three brainstorming sessions, after which the questionnaire items' composition was deemed suitable for the purpose of the research.

The importance and performance variables for the PBL education model comprised aspects such as communication, problem solving, self-directed learning, team learning, and confidence and achievement (Table 2). The values of the Cronbach's  $\alpha$  test ranged from a minimum of 0.801 to a maximum of 0.922, indicating the reliability and internal consistency of the importance and performance variables. The questionnaires were measured on a 5-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5). Table 2 shows the results of the IPA factor analysis of the PBL education model for sports courses.

## 2.3. Data Analysis

Data from the 331 valid questionnaires were statistically analyzed using SPSS version 25.0. First, a frequency analysis was conducted on the demographic characteristics of the study sample. Second, to investigate the validity and reliability of the questionnaire as a survey tool, exploratory factor analysis and reliability analysis using Cronbach's  $\alpha$  coefficient were conducted. Third, a priority analysis using descriptive statistics was conducted to determine whether there was a significant difference in the importance and execution level of the PBL education model and to compare and analyze the average values. Fourth, a final verification was performed using the IPA matrix to interpret the coordinates located in each quadrant.

**Table 2.** Results of reliability analysis: importance and performance of PBL education model.

Factor	Items	1	2	3	4	5
Communication	Proactive communication	0.929				
	Creative communication	0.917				
	Communication with team members	0.903				
	Understanding others' point of view	0.889				
Problem-solving	Getting to the heart of the matter		0.904			
	Gathering information related to the problem		0.877			
	Determining the cause of the problem		0.851			
	Prioritizing the problem-solving method		0.834			
Self-directed learning	Planning for yourself when learning			0.830		
	Actively answering questions			0.811		
	Considering the importance of self-learning			0.808		
	Proper planning and execution			0.793		
Team learning	Enthusiasm and sincerity for team learning				0.789	
	Everyone on the team works hard				0.777	
	The joy of team learning				0.763	
	Building intimacy among team members				0.751	
Confidence and achievement	Increase in self-confidence					0.732
	Feeling a sense of accomplishment					0.720
	Feeling a sense of challenge					0.711
	Obtaining sufficient knowledge through learning					0.708
	Eigenvalues	3.880	3.640	3.423	3.018	2.814
	% of Variance	14.235	12.188	11.365	9.771	8.232
	Cumulative %	14.235	26.423	37.788	47.559	55.791
	Cronbach's $\alpha$	0.922	0.901	0.886	0.834	0.801

### 3. Results

#### 3.1. Priority Analysis of the Importance and Performance of the PBL Education Model

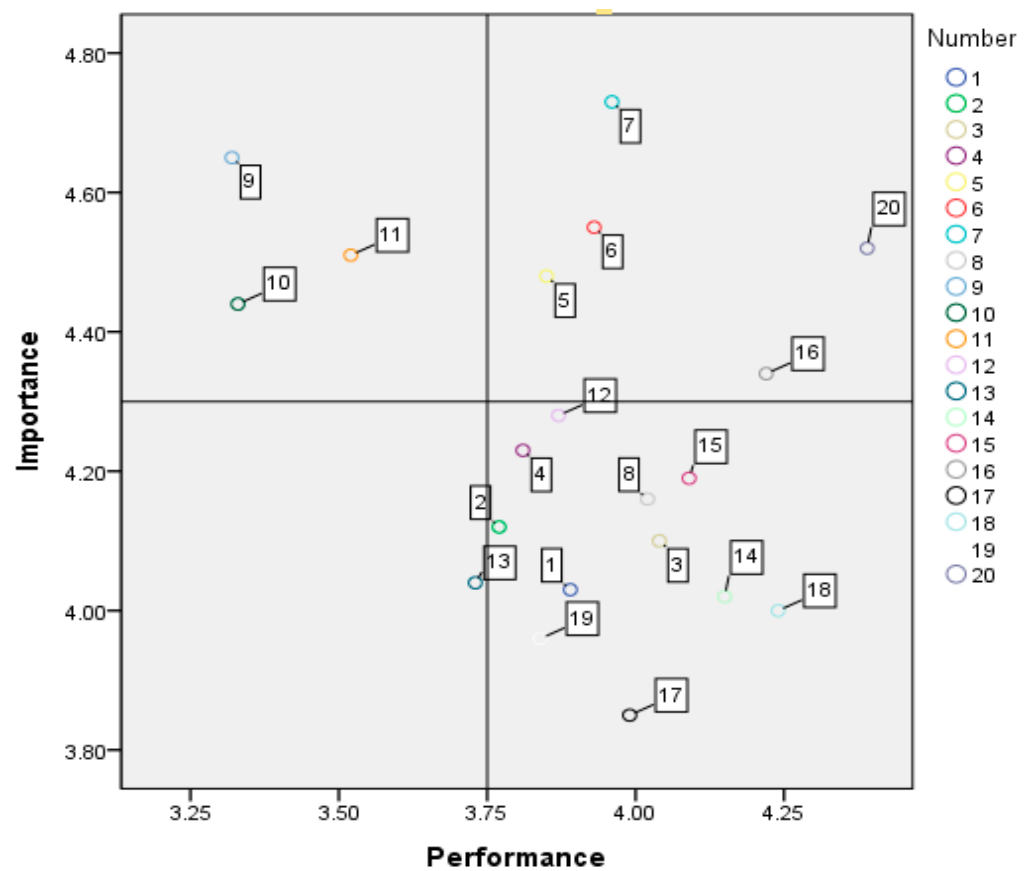
Table 3 shows the priority analysis results regarding the importance attributed by students to different aspects of the PBL education model and student performance. The highest average value for each factor is shown below. In terms of importance, problem solving (4.48) received the highest scores followed by self-directed learning (4.47), team learning (4.15), communication (4.12), and confidence and achievement (4.08); as part of these attributes, determining the cause of the problem, planning for yourself when learning, building intimacy among team members, understanding others' point of view, and obtaining sufficient knowledge through learning, were deemed as especially important, respectively. Next, in terms of performance, as well as importance, the results showing high average values are as follows. The students performed the best in confidence and achievement (4.12), team learning (4.05), problem solving (3.94), communication (3.88), and self-directed learning (3.51). Within these attributes, students showed high performance in obtaining sufficient knowledge through learning (confidence and achievement), building intimacy among team members (team learning), prioritizing the problem-solving method (problem solving), communicating with team members (communication), and proper planning and execution (self-directed learning).

#### 3.2. IPA Matrix of the PBL Education Model

The IPA was used to simultaneously analyze the importance and performance of each attribute of the PBL education model. In general, the IPA matrix was used to calculate the standard deviation of the intersection point criterion and was automatically randomly converted to a statistical program. The IP intersection was set with an importance of 4.30 and an execution degree of 3.75 centered on the median value of the whole. The  $x$ -axis represents the performance attribute, and the  $y$ -axis represents the importance attribute. The results are shown in Figure 2 and Table 4.

**Table 3.** Importance–Performance and priority analysis of the problem-based learning education model.

Factor	Questionnaires	Importance		Performance			
		Rank	<i>M ± SD</i>	Rank	<i>M ± SD</i>		
Communication	Proactive communication	16	4.03	0.811	11	3.89	0.876
	Creative communication	13	4.12	0.962	16	3.77	0.916
	Communication with team members	14	4.10	0.936	6	4.04	0.962
	Understanding others’ point of view	10	4.23	0.882	15	3.81	0.905
Problem-solving	Getting to the heart of the matter	6	4.48	0.889	13	3.85	0.856
	Gathering information related to the problem	3	4.55	0.889	10	3.93	0.994
	Determining the cause of the problem	1	4.73	0.875	9	3.96	0.989
	Prioritizing the problem-solving method	12	4.16	0.904	7	4.02	1.047
Self-directed learning	Planning for yourself when learning	2	4.65	0.911	20	3.32	0.745
	Actively answering questions	7	4.44	0.861	19	3.33	0.788
	Considering the importance of self-learning	5	4.51	0.845	18	3.52	0.956
	Proper planning and execution	9	4.28	0.913	12	3.87	0.815
Teamlearning	Enthusiasm and sincerity for team learning	15	4.04	0.904	17	3.73	0.856
	Everyone on the team works hard	17	4.02	1.038	4	4.15	0.877
	The joy of team learning	11	4.19	1.004	5	4.09	0.926
	Building intimacy among team members	8	4.34	0.926	3	4.22	1.095
Confidence and achievement	Increase in self-confidence	20	3.85	0.962	8	3.99	1.033
	Feeling a sense of accomplishment	18	4.00	0.989	2	4.24	0.965
	Feeling a sense of challenge	19	3.96	0.883	14	3.84	0.988
	Obtaining sufficient knowledge through learning	4	4.52	0.876	1	4.39	0.863
Total			4.26			3.90	



**Figure 2.** Importance and performance matrix of the problem-based learning education model.

**Table 4.** Importance and performance matrix results of the problem-based learning education model.

Quadrant	Items
Quadrant 1	Determining the cause of the problem, obtaining sufficient knowledge through learning, gathering information related to the problem, getting to the heart of the matter, building intimacy among team members
Quadrant 2	Planning for yourself when learning, considering the importance of self-learning, actively answering questions
Quadrant 3	Enthusiasm and sincerity for team learning
Quadrant 4	Proper planning and execution, understanding others' point of view, the joy of team learning, prioritizing the problem-solving method, creative communication, communication with team members, proactive communication, everyone on the team works hard, feeling a sense of accomplishment, feeling a sense of challenge, increase in self-confidence

#### 4. Discussion

The purpose of this study was to comprehensively analyze the degree to which sports majors' value the elements implemented in the PBL education model in terms of application and evaluation by using the IPA matrix to consider the strengths of the PBL model. The results analyzed according to the purpose of the study are discussed as follows. Q1, indicating high importance and high performance in the PBL education model, included aspects such as determining the cause of the problem, providing sufficient knowledge through learning, gathering information related to the problem, getting to the heart of the matter, and building intimacy among team members. These five items required continuous maintenance. For instance, problem solving, which involves identifying the cause of the problem, a core of the PBL education model, requires continuous efforts by sports majors. According to Duncan and Al-Nakeeb [33], the problem-solving ability of sports majors is influenced by various factors, and requires the use of various sports-related knowledge and skills. By using knowledge such as exercise physiology, exercise training, and sports psychology, athletes can solve problems by optimizing their physical strength and performance [7]. Therefore, through the PBL education model, sports majors can acquire professional knowledge and skills in the field, evaluate their abilities and skills, identify problems, and seek solutions through active communication with various members. From this perspective, sports majors who receive PBL education are able to demonstrate creative thinking and problem-solving abilities when faced with problems, and acquire sufficient knowledge through learning, which needs to be maintained for their sustainable development [8,34]. In the PBL education model, the formation of intimacy among team members is an important factor for effectively carrying out a team project. The establishment of open and mutually respectful communication and an environment that allows team members to freely share their opinions will also help sports majors improve their leadership [6].

Q2, indicating high importance and low performance in the PBL education model, includes planning for oneself while learning, considering the importance of self-learning, and actively answering questions. These three items can be considered as requiring intensive efforts for improvement at the present time. The results confirmed that none of the three items performed well in terms of self-directed learning.

First, goal setting involves setting specific, measurable, and realistic goals for self-directed learning. Second, self-evaluation involves identifying strengths and weaknesses and finding ways to improve them. Third, research on learning materials should improve professionalism by instilling the habit of reviewing the latest research and data. Fourth, students should make a learning plan by selecting a topic related to one's learning goals and planning a study schedule. The fifth is self-motivation: learning about intrinsic motivation, passion, and interest in learning [35,36]. These results are supported by the findings of Coyne et al. [15], who found that it is difficult for professors teaching sports majors to induce

learners' self-directed learning in project-based learning. However, difficulties in setting specific goals, a lack of motivation, and difficulties in researching and planning learning materials could also impact students' ability to engage in self-directed learning. To solve this problem, active intervention by professors has been reported to play an important role in helping with self-directed learning in the PBL education model [37]. Therefore, professors should encourage greater interactions and discussion and support goal setting among learners who find it difficult to engage in self-directed learning. As the PBL education model takes a different approach from the existing lecture-centered learning method, sports majors may find the new learning method unfamiliar. Therefore, efforts should be made to minimize uncertainty and discomfort regarding learning methods; this process will be necessary for the sustainable development of sports majors. As mentioned earlier, the process of selecting an appropriate and interesting topic through the active intervention of the professor is important for implementing the PBL education model [38,39]. This is because selecting PBL topics for sports-related subjects can be challenging. Therefore, the choice of topic should focus on students' interests and practical problems.

Q3, which indicates low importance and performance in the PBL education model, includes enthusiasm and sincerity toward team learning. This single item is not a priority at this point. In team learning, enthusiasm and sincerity refer to a mental attitude in which team members participate in learning activities with high interest and dedication and strive to achieve a common goal [40]. The reason this was given a low priority was because PBL subjects follow a learning method different from those used in general subjects, and only a select few students want to take such courses; those who did, did so out of their own choice. Therefore, as it is an educational model that solves realistic problems related to sports or sets goals and strives to achieve them, it can be interpreted that the learners' enthusiasm and sincerity levels are adequate at present. For the sustainable development of sports majors, it is necessary for them to try new subjects such as PBL.

Q4, indicating low importance but high performance in the PBL education model, included proper planning and execution, understanding others' point of view, the joy of team learning, prioritizing the problem-solving method, creative communication, communicating with team members, proactive communication, and ensuring that everyone on the team works hard, feels a sense of accomplishment, a sense of challenge, and an increase in self-confidence. Although these aspects are important in general, currently, they are being well executed within the purview of the PBL education model. Therefore, it is necessary to closely review the related items while designing the curriculum. If many items are included in a specific quadrant of the IPA matrix, it is necessary to redistribute the subjects, as pointed out by Phadermrod et al. [41]. Students performed well in terms of terms of confidence and achievement, including aspects such as creative communication, smooth communication with team members, proactive communication, understanding others' perspectives, sense of achievement, sense of challenge, and self-confidence improvement, compared with their performance in general subjects. These results reflect the areas in which the PBL education model is doing well, and conform with the findings of Sistermans's [24] online health-related study. In fact, because the sports-related PBL education model includes not only theory, but also practical aspects, it is necessary to solve problems with practical items centered on periodic communication between professors and learners [42]. For example, if the PBL education model is applied to a class that solves diet problems for health management, additional goals and problems such as weight loss and physical fitness improvement should be set in addition to numerical goals, and then these goals should be balanced out. These additional goals could include maintaining a well-balanced diet; increasing nutrient intake through food that is rich in nutrients and low in calories; and combining aerobic and resistance exercises to improve physical fitness in addition to focusing on diet. These problems are also suitable for PBL classes [43]. The application of the PBL education model should provide new challenges for sports majors for their sustainable development, and universities and professors should proactively apply the PBL education model to sports subjects to resolve the students' unfamiliarity



and discomfort with the subject and improve their participation. Active intervention and efforts are required in this regard.

## 5. Conclusions

The PBL education model is an educational model that develops students' ability to transcend academic boundaries, solve realistic problems, engage in self-directed learning, collaborate and communicate, and integrate and utilize in-depth understanding and critical thinking. In recent years, several scholars have highlighted the need for adopting this educational model for sports majors. Accordingly, this study aimed to present an educational direction for the sustainable development of sporting education using a PBL-based education model by examining the perspectives of sports major students. The study makes the following contributions.

First, it confirmed that sports majors need to continuously focus on problem-solving skills. To this end, sports majors should be trained to use their knowledge such as exercise physiology, exercise training, and sports psychology to optimize the physical demands and performance of athletes. In addition, it confirmed that maintaining creative thinking and problem-solving abilities and acquiring sufficient knowledge through learning are core requirements for sustainable development. Next, the formation of intimacy between team members in sports majors is an important factor that requires continuous attention, because an environment that fosters open communication allows team members to share problem-solving goals and extend mutual support.

Second, this study confirmed that the self-directed learning method did not perform well because of difficulties in setting specific goals, lack of motivation, and difficulties in researching and planning learning materials. Therefore, to foster self-directed learning in the PBL education model, the professors should actively intervene to support learners in setting goals and encourage interaction and discussion.

Third, the enthusiasm and sincerity for team learning appeared to be a low priority, which could be because PBL subjects use different teaching methods from general subjects, and students who take such courses do so out of their own choice.

Fourth, compared with general subjects, the PBL education model performed well in terms of improving students' communication, self-confidence, and sense of achievement. As the sports-related PBL education model includes not only theory but also practical aspects, the curriculum must focus on problem-solving practical concerns based on periodic communication between professors and learners. In particular, it was confirmed that for the sustainable development of sports courses and to achieve the purpose of the PBL education model, this model should be applied to practical problems in the sports curriculum such as solving diet problems for health management.

Through this study, the elements that should be improved and maintained in the application of the PBL education model to sports majors were identified. However, there were limitations in the study, and the direction of future research is presented as follows. First, this study used the IPA method to closely analyze the application of the PBL model based on the evaluation of sports majors, and quantitatively investigated the degree to which each item needs further maintenance and improvement. Future research could focus on collecting qualitative data using in-depth interviews to determine why the self-directed learning method was not implemented well in the PBL model; this would help understand the inner world of the actual learner.

Second, the study was conducted from the perspective of PBL learners. Future studies could focus on converging the learners' perspective with those of the instructors to gain a comprehensive understanding of the various constraints, such as the difficulty in implementing the PBL model and communicating with students.

Third, this study was only conducted with sports majors, and meaningful research results could be derived if differences and similarities were found through a comparison of students majoring in different subjects.

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**Data Availability Statement:** Not applicable.

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