Journal of Engineering Science and Technology
Special Issue on ISCoE2024 Vol. 20 No. 4 (2025) 80 - 87

INDIVIDUALIZED TEACHING OF PHYSICAL CULTURE THEORY THROUGH A SCIENCE AND ENGINEERING EDUCATION FRAMEWORK

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Abstract

This study introduces a pedagogical model to develop professional activity competence in future physical education teachers using an individualized approach supported by blended learning. Drawing from the principles of science and engineering education, the model integrates practical, cognitive, and technological components to promote skill development and instructional effectiveness. A three-phase research design (diagnostic assessment, model construction, and pedagogical experimentation) was applied, involving 142 university students. Data were gathered through observations, interviews, tests, and statistical analysis. The findings revealed high student motivation and competence acquisition within blended environments, while also identifying key challenges such as limited motivation for physical endurance and insufficient self-regulation. By incorporating design-based and technology-enhanced strategies rooted in science and engineering education, the study offers a replicable framework for enhancing physical education teacher training. This model supports the development of adaptive, skilled educators and contributes to broader efforts in reforming competency-based education in interdisciplinary settings.

Keywords: Blended learning, Competency development, Physical education, Science and engineering education, Teacher preparation.

1. Introduction

Professional competence is increasingly essential in preparing future teachers to meet modern educational demands [1, 2]. Concepts such as competence, blended learning environments, and educational clusters are central in shaping educators capable of connecting theory with practice. Recent developments in science and engineering education have introduced performance-based, technology-driven, problem-solving models that are now being adapted across disciplines, including physical education.

Table 1 shows previous research regarding physical education. Research has highlighted the value of competency-based instruction, collaborative clusters, and blended methodologies in improving teacher preparation. These contributions outline prior studies that form the foundation for this research.

Table 1. Previous research on physical education.

No.	Title	Ref.
1	Boxing training technology based on the level of physical development of children.	[3]
2	Development analysis research on physics education by mapping keywords using the VOSviewer application.	[4]
3	The efficiency of the experimental methods of improving complex technical and tactical actions of boxers	[5]
4	A critical success factors model for golf athletes' talent development in Malaysia and Indonesia	[6]
5	Improving the effectiveness of the method of conducting physical education classes for students of grades 5-9 in hot climates	[7]
6	Different types of yoga as a sport	[8]
7	Technologies for selecting boxers and preparing them for competitions	[9]
8	Bibliometric analysis of research development in sports science with VOSviewer	[10]
9	The mechanism of development of professional and pedagogical creativity of future physical education teachers based on a competent approach	[11]
10	Nutritional research mapping for endurance sports: A bibliometric analysis	[12]
11	Development of the theoretical foundations of sports activity (sports business) in post-industrial conditions	[13]
12	Effect small side games (SSG) on playing skills in handball sports	[14]
13	Analysis of boxers' pulse oximeter and chronometry ability to perform during boxing	[15]
14	Yoga and weight management	[16]

Despite these advancements, few models emphasize individualized instruction integrated with blended and cluster-based environments. Drawing on innovations from science and engineering education, this study aims to develop and validate a pedagogical model that enhances the professional activity competence of future physical education teachers. Its novelty lies in merging personalized learning with structured, interdisciplinary methods, creating a scalable and modern training approach.

2. Literature Review

Figure 1 shows the concept in this study. Teacher professional competence has been examined through various lenses, emphasizing its development as a holistic system. Pedagogical technologies have been shown to improve subject delivery and student engagement, while educational clusters promote collaboration and shared resources in teacher training. Competency-based approaches focus on measurable outcomes aligned with workplace demands.

Blended learning methods, increasingly adopted in higher education, combine flexibility and skill-based training across disciplines. Effective teacher preparation depends on modelling professional behaviour, encouraging independent learning, and using innovative pedagogy. In blended environments, these skills can be developed through structured activities, digital integration, and feedback mechanisms. Addressing practical competence is essential for preparing adaptive, future-ready physical education teachers.

Science and engineering education emphasizes problem-solving, performance-based learning, and digital integration, principles that align well with modern physical education training. These disciplines use simulations, modelling, and iterative practice to build competence, providing transferable methods for blended and competency-based instruction [17]. Their interdisciplinary focus also promotes self-directed learning and adaptability, both critical for developing reflective, skilled physical education teachers [18, 19].

Despite progress, several barriers hinder competence development, including low student motivation, limited access to updated literature, weak collaboration within clusters, and underdeveloped self-regulation. These issues highlight the need for targeted support systems and personalized learning strategies. Adapting successful practices from science and engineering education, such as design thinking and performance-based assessment, can help overcome these challenges [17, 18].

3. Method

This study employed a multi-stage methodological design to develop and evaluate the professional activity competence of future physical education teachers within a blended learning environment. Detailed information for this method is explained elsewhere [20].

This study followed a three-phase research design: diagnostic analysis, model development, and experimental validation. In the first phase, pedagogical-psychological analysis was conducted through observations, trial lessons, interviews, surveys, and comparative review of best practices. The second phase involved constructing a theoretical model for developing activity competence, supported by programmatic-methodical materials tailored to blended learning environments.

In the final phase, a pedagogical experiment was carried out to evaluate the model's effectiveness. Assessment criteria were developed, and results were analysed using statistical methods to refine the model and confirm the research hypothesis.

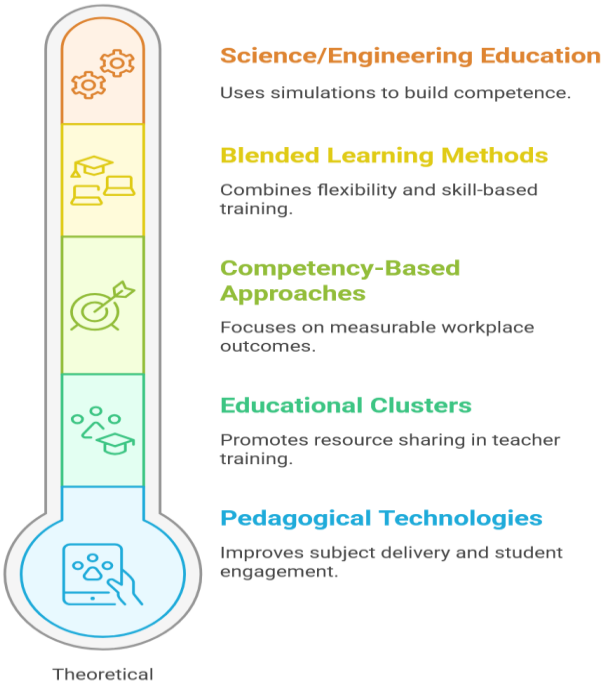

Fig. 1. The concept.

4. Results and Discussion

Table 2 explains the distribution of student activity competence and motivation among 142 participants. The data highlight strengths in motivational and activity components, alongside technological application. Table 3 explains how these specific challenges impact students' competency development and instructional effectiveness.

Table 2. Student activity competence and motivation evaluation results.

No.	Criteria	Percentage
1	Motivational Component	
2	Pedagogical attitude toward blended learning	70%
3	Use of information-communication technologies	65%
4	Mastery of blended learning methods	60%
5	Activity Component	
6	Competence acquisition in a blended environment	75%
7	Personal, professional, and social development	68%
8	Barriers and Challenges	
9	Low motivation for physical endurance	14%
10	Lack of methodological literature	20%
11	Weak collaboration among cluster entities	18%
12	Low self-development commitment	34%
13	Unclear personal educational goals	29%
14	Difficulty using learning materials	16%
15	Other factors	3%

Table 3. Challenges and barriers in competency development for physical education students.

Challenge	Affected	Impact on Competency Development
Low motivation for endurance training	14%	Slows physical skill development
Lack of methodological literature	20%	Limits teaching preparation and content depth
Weak cluster collaboration	18%	Reduces interdisciplinary and peer-supported learning
Low self-development and endurance commitment	34%	Hinders long-term professional readiness
Unclear personal goals	29%	Disrupts focused and structured learning
Difficulty using materials	16%	Affects engagement with instructional tools
Other factors	3%	Includes external or individual barriers

The findings demonstrate that students exhibit a relatively high level of motivation and emerging professional competence within a blended learning framework, yet face consistent challenges in self-regulation, endurance training, and access to methodological resources. These outcomes align with broader research in science and engineering education, where similar issues of learner engagement, content accessibility, and applied skill development have prompted the integration of technology-driven instructional models [17, 18, 21].

In science education, for example, the use of performance-based tasks, simulations, and real-world problem-solving has proven effective in translating theoretical knowledge into actionable competencies, a strategy directly applicable to physical education settings. Furthermore, the interdisciplinary model from STEM education promotes self-directed learning and the development of metacognitive skills, both of which are crucial for sustaining long-term professional growth among future physical education teachers [19, 22-25].

Integrating such strategies into physical culture training can foster reflective practice, data-driven assessment, and iterative skill acquisition, thereby strengthening both academic and physical domains of competence. Addressing the observed barriers through a cross-disciplinary lens offers a more robust and scalable pathway for improving teacher education in physical culture.

5. Conclusion

This study proposed and validated a pedagogical model to develop professional activity competence in future physical education teachers through a blended learning approach. Results showed strong student motivation and competence acquisition, particularly in environments that integrated theory with practice. Despite these strengths, challenges such as low motivation for endurance training, limited methodological resources, and weak self-regulation were identified.

The study highlights that incorporating strategies from science and engineering education, such as performance-based learning and digital tools, can enhance reflective practice and adaptive skill development. The model confirms the value

of personalized, cluster-based, and technology-supported instruction, offering a scalable framework for competency-based physical education training.

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