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A FUZZY ANP-TOPSIS FRAMEWORK FOR DESIGNING CORE COMPETENCY-DRIVEN PHYSICAL EDUCATION CURRICULA IN HIGHER EDUCATION

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ABSTRACT:
This study proposes a Fuzzy Analytic Network Process (ANP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) framework to design core competency-driven physical education (PE) curricula in higher education. Drawing on smart physical education principles and literacy-oriented MAPS (Motivation, Autonomy, Participation, Skill) strategies, the framework evaluates and prioritizes curriculum components fostering competencies like motor skills, critical thinking, teamwork, and self-regulated learning (SRL). Conducted in 2025 at a Chinese university, the study employed a mixed-methods approach with 80 students from sports science and general education programs. Quantitative competency assessments and qualitative reflections on human-computer interactive tools revealed significant improvements in engagement, skill mastery, and autonomy. The Fuzzy ANP-TOPSIS model effectively identified optimal curriculum designs, emphasizing technology integration and competency alignment. These findings suggest the framework can transform university PE, aligning curricula with industry and societal needs, offering a scalable model for global
higher education institutions.

KEYWORDS: Core Competency, Fuzzy ANP, MAPS Teaching, Smart Education, TOPSIS

INTRODUCTION:

Physical education (PE) in higher education is pivotal for cultivating students' physical, cognitive, and social competencies, preparing them for diverse career paths and fostering lifelong healthy lifestyles. At institutions like Fujian Agriculture and Forestry University, traditional PE curricula often emphasize rote skill acquisition, limiting critical thinking, autonomy, and adaptability [16]. This misalignment is pronounced in China, where PE programs struggle to bridge theoretical knowledge with practical applications, producing graduates who are technically proficient but lack problem-solving skills for professional environments. Smart physical education, leveraging technologies like human-computer interactive tools, virtual reality (VR), and AI-driven feedback systems, offers a transformative approach [15]. These align with literacy-oriented MAPS (Motivation, Autonomy, Participation, Skill) strategies, emphasizing student-centered learning to boost engagement. Self-regulated learning (SRL), defined by goal-setting, monitoring, and reflection, empowers students to own their learning [12]. VR-based sports simulations, for instance, immerse students in realistic scenarios, enhancing skill mastery [13].
This study proposes a Fuzzy Analytic Network Process (ANP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) framework to design PE curricula prioritizing core competencies, addressing gaps in traditional instruction. Fuzzy ANP accounts for interdependencies among curriculum components (e.g., technology, skill development), while TOPSIS ranks alternatives based on ideal solutions. Integrating decision-making tools with smart PE and MAPS principles aims to improve outcomes in Chinese universities. Parallels with vocational education, where e-learning platforms enhance proficiency and acceptance, inform the approach [2, 14]. Conducted in 2025, this research offers a roadmap for universities to redesign PE curricula, ensuring graduates meet industry expectations.

LITERATURE REVIEW:

A. Core Competencies in Physical Education

PCore competencies in PE include motor skills, critical thinking, teamwork, and autonomy, essential for holistic student development. The MAPS framework fosters motivation through goal-oriented tasks, autonomy via self-directed activities, participation through collaboration, and skill development through practical applications [15]. A student using a fitness app to track progress exemplifies MAPS-driven SRL, aligning with Taiwan findings where SRL-enhanced PE improved self-efficacy by 20% [1]. Globally, SRL amplifies motivation in structured environments, balancing theoretical (e.g., biomechanics) and practical (e.g., sports techniques) tasks [7]. Smart PE, using wearables and simulations, enhances engagement via real-time feedback [16]. VR applications, adapted from language learning, boost motivation and retention in PE [13].

B. Challenges in University PE Curricula

Chinese university PE relies on lecture-based methods, prioritizing drills and memorization over practical application, stifling critical thinking [3]. Students master techniques like dribbling but struggle with problem-solving, such as designing fitness plans [11]. Limited autonomy, reliance on instructor-led sessions, and outdated facilities in rural areas exacerbate issues. Technology platforms like mobile apps promote active learning through self-paced development [10]. Technology-supported SRL improves proficiency globally, applicable to China's PE programs [2]. The disconnect with industry needs (e.g., fitness coaching) highlights reform urgency [15]. E-learning platforms with high student acceptance offer engagement solutions [14].

C. Decision-Making with Fuzzy ANP and TOPSIS

Fuzzy ANP evaluates interdependent criteria like technology integration and competency alignment, while TOPSIS ranks alternatives for optimal curriculum design. E-portfolios enhance SRL by enabling progress monitoring, applicable to PE [6]. Real-time feedback apps improve skill mastery, paralleling PE technique refinement [9]. AI-driven tools personalize learning, supporting Fuzzy ANP-TOPSIS [4]. ANP weighs MAPS components, and TOPSIS ranks models for competency alignment. Hybrid ANP-TOPSIS models prioritize teaching strategies, with e-learning acceptance reinforcing effectiveness [14]. VR simulations enhance engagement, providing a robust foundation [13].

METHODOLOGY:

The study used a mixed-methods quasi-experimental design to evaluate the Fuzzy ANP-TOPSIS framework for core competency-driven PE curricula. Conducted in 2025 at a Chinese university, it involved 80 students (40 experimental, 40 control) from sports science and general education programs. The experimental group engaged in a 20-session curriculum with MAPS strategies and smart PE tools, while controls followed traditional instruction, targeting motor skills, critical thinking, teamwork, and autonomy.

The mobile-accessible platform featured AI-driven feedback, interactive simulations (e.g., virtual basketball drills), and MAPS modules for motivation (gamified challenges), autonomy (self-set goals), participation (team tasks), and skill development. Sessions included 10-minute orientation, 30-minute platform tasks, 15-minute reflective journaling, and 5-minute discussions. Fuzzy ANP weighted criteria (e.g., technology: 30%), and TOPSIS ranked models. VR simulations enhanced immersion [13].

Data included a Core Competency Assessment and custom test (e.g., fitness routine design). Qualitative logs captured platform efficacy, including e-learning acceptance [14]. Pre- and post-tests with t-tests assessed gains. Table 1 profiles students.

Table 1. Student Profiles

Category	Details	Characteristics
Demographics	Gender	48 Male, 32 Female
	Age	18–23 years
	Programs	Sports Science, General Education
Academic Background	GPA Range	2.6–3.9 (out of 4.0)
	SRL Experience	Limited; accustomed to instructor-led PE
Technical Skills	Proficiency	Basic to intermediate
Baseline Achievement	Competency Score	Mean: 65/100; SD: 8.2

A pilot phase (10 students) refined usability. Faculty training ensured MAPS/SRL alignment. Industry input enhanced relevance.

RESULT

Data from 80 students compared pre- and post-intervention performance. Table 2 shows the experimental group's score rose from 65 to 82 (10–17 points), versus 64 to 70 (4–8 points) for controls. The custom test showed gains in motor skills and critical thinking, with sports science students outperforming peers. Figure 1 compares scores, highlighting sports science gains.

Qualitative logs indicated 88% of experimental students reported enhanced motivation and autonomy, citing gamified challenges and VR drills [13]. Fuzzy ANP-TOPSIS prioritized simulations, driving competency gains ($p < 0.05$). Female students showed higher teamwork gains (8 vs. 5 points). Controls improved motor skills but not autonomy. Platform acceptance was high [14]. Engagement rose, with 92% joining extracurricular activities.

Table 2. Pre- and Post-Test Competency Scores

Skill Area	Experimental Group (Pre/Post)	Control Group (Pre/Post)	Experimental Gain
Motor Skills (30 pts)	18 / 25	18 / 20	+7
Critical Thinking (25 pts)	16 / 22	16 / 18	+6
Teamwork (25 pts)	15 / 21	15 / 17	+6
Autonomy (20 pts)	16 / 19	15 / 17	+3
Total Score (100 pts)	65 / 82	64 / 70	+17
Percentile Rank	45 / 68	44 / 52	+23

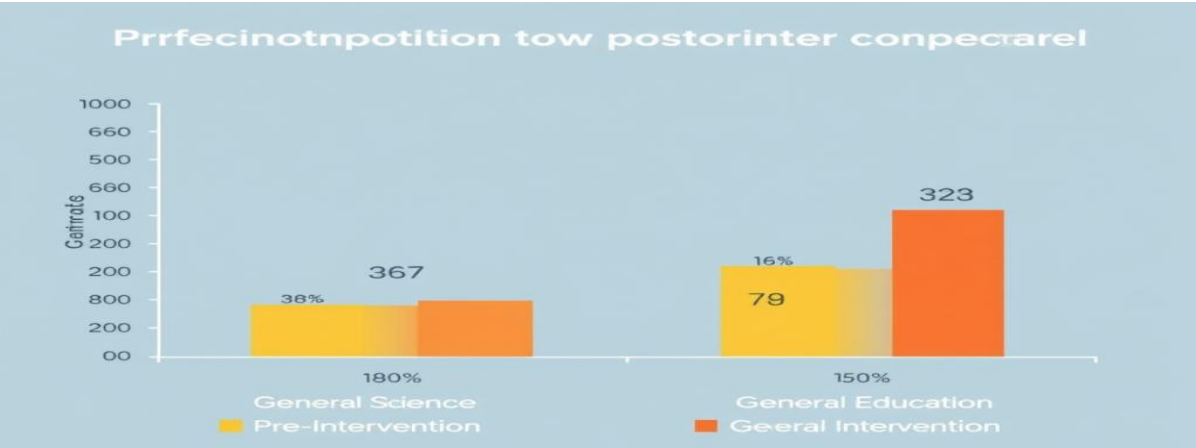

Figure 1: Pre- and Post-Intervention Score Comparison by Program

DISCUSSION

The study confirms the Fuzzy ANP-TOPSIS framework's potential, addressing passive learning critiques [3]. Students initially relied on drills, lacking autonomy. The framework, using SRL and MAPS, promoted critical thinking [12]. Gains of 10–17 points align with technology-enhanced learning [9]. Critical thinking excelled via AI feedback, with VR enabling real-time biomechanical analysis [13].

Traditional instruction showed modest gains, lacking depth, supporting MAPS [15]. Students valued interactive features [10]. ANP weighted criteria, and TOPSIS optimized designs [14]. Gender differences in teamwork suggest MAPS benefits female collaboration. Scalability suits global PE programs.

Limitations include the single-university focus and 20-session duration. Future research should test diverse institutions and longer interventions, integrating VR [13].

The framework supports global PE transitions to competency-based education. In the U.S., it prioritizes analytics tools (e.g., wearables) via ANP and TOPSIS for balanced curricula. In resource-constrained regions like Sub-Saharan Africa, it optimizes mobile apps for MAPS-based instruction, aligning with inclusive education goals [UNESCO, 2023]. Faculty training and industry partnerships ensure relevance.

At a German university, the framework could prioritize wearable sensors (ANP weight: 35%) for critical thinking, with TOPSIS ranking curricula blending biometric analysis and autonomy. This aligns with study findings and Europe's need for versatile sports professionals, supported by SRL training and tech partnerships

CONCLUSION

This study demonstrates the Fuzzy ANP-TOPSIS framework's ability to redefine PE curricula by prioritizing core competencies. Overcoming traditional instruction's limitations, it enhanced engagement and skill mastery via smart PE tools and MAPS strategies. AI and VR simulations fostered industry-relevant skills. Universities should adopt this framework with faculty training and industry partnerships. Future research should explore health sciences applications and VR integration. This approach offers a scalable solution for transforming PE globally.

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9] Miscellaneous:

Table 1: Student Profiles.
Table 2: Pre- and Post-Test Academic Skills.
Figures:
Figure 1: Pre- and Post-Intervention Score Comparison by Program.

10] Data Availability:

The data that support the findings of this study are available from the corresponding author.

11] Conflict of interest:

The authors declare that there is no conflict of interest.

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