Multimedia-based 7E instructional model to enhance student engagement and floor-gymnastics skills in elementary Physical Education

Modelo instruccional 7E basado en multimedia para mejorar la participación del estudiante y las habilidades de gimnasia en el suelo en la Educación Física de primaria

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Abstract

Introduction: Gymnastics is a core component of elementary physical education, yet its instruction is challenged by heterogeneous abilities, safety demands, and declining student engagement.
Objective: This study aimed to examine the association between a multimedia-based 7E instructional model and changes in student engagement and floor-gymnastics performance in elementary physical education.
Methodology: A quasi-experimental one-group pretest–posttest design was conducted with 100 third-grade students from four public elementary schools. The four-week intervention integrated an Android application, video modeling, animations, and digital task cards into the phases of the 7E model. Student engagement (behavioral, cognitive, and affective) and gymnastics skills were measured using structured observations, questionnaires, and rubric-based performance tests, and data were analyzed using descriptive statistics and paired-sample t-tests.
Results: showed that mean engagement scores across all 7E phases exceeded the active threshold, with the highest values in phases emphasizing initial motivation, exploratory practice, and extended application. Gymnastics scores increased significantly in all schools, with substantial pretest–posttest gains and upward shifts in the full score distributions, reflecting positive changes in technique, body control, and continuity.
Conclusions: The findings indicate that the multimedia-based 7E instructional model is associated with sustained student engagement and meaningful improvements in elementary floor-gymnastics skills, supporting its potential as a differentiated, technology-enhanced instructional framework in physical education.

Keywords

Digital pedagogy; 7E instructional model; elementary gymnastics; multimedia learning; Physical Education.

Resumen

Introducción: La gimnasia es un componente central de la educación física en la escuela primaria; sin embargo, su enseñanza enfrenta desafíos derivados de la heterogeneidad de las habilidades del alumnado, las exigencias de seguridad y la disminución del compromiso estudiantil.
Objetivo: Este estudio tuvo como objetivo examinar la asociación entre un modelo de instrucción 7E basado en multimedia y los cambios en el compromiso de los estudiantes y el desempeño en gimnasia de suelo en la educación física de nivel primario.
Metodología: Se llevó a cabo un diseño cuasi experimental de un solo grupo con pretest y postest en 100 estudiantes de tercer grado de cuatro escuelas primarias públicas. La intervención de cuatro semanas integró una aplicación Android, modelado en video, animaciones y tarjetas de tareas digitales en las fases del modelo 7E. El compromiso estudiantil (conductual, cognitivo y afectivo) y las habilidades gimnásticas se midieron mediante observaciones estructuradas, cuestionarios y pruebas de desempeño basadas en rúbricas, y los datos se analizaron utilizando estadística descriptiva y pruebas t para muestras relacionadas.
Resultados: Los resultados mostraron que las puntuaciones medias de compromiso en todas las fases del modelo 7E superaron el umbral de actividad, con los valores más altos en las fases que enfatizan la motivación inicial, la práctica exploratoria y la aplicación extendida. Las puntuaciones en gimnasia aumentaron significativamente en todas las escuelas, con ganancias sustanciales entre el pretest y el postest y desplazamientos ascendentes en las distribuciones completas de puntuaciones, lo que refleja cambios positivos en la técnica, el control corporal y la continuidad.
Conclusiones: Los hallazgos indican que el modelo de instrucción 7E basado en multimedia se asocia con un compromiso estudiantil sostenido y mejoras significativas en las habilidades de gimnasia de suelo en la educación primaria, lo que respalda su potencial como un marco de enseñanza diferenciado y enriquecido con tecnología en la educación física.

Palabras clave

Pedagogía digital; modelo instruccional 7E; gimnasia escolar; aprendizaje multimedia; Educación Física.

Introduction

Gymnastics is widely recognized as a foundational component of elementary physical education (PE) because it supports the development of gross motor skills, balance, coordination, and body awareness, all of which are essential for lifelong physical activity. Yet, teaching gymnastics to young learners is pedagogically complex. Classrooms are typically characterized by heterogeneous physical abilities, prior experiences, and levels of confidence, which makes it difficult for teachers to apply a single, standardized instructional approach. Educators are thus required to tailor instructional strategies so that all students feel included and capable of participating in gymnastics activities. Recent evidence on rhythmic gymnastics shows that appropriately adapted teaching practices can substantially enhance gross motor skills among young children, underscoring the pedagogical importance of differentiation in gymnastic instruction (Milosis & Siatras, 2022; Pradipta et al., 2023; Astutik et al., 2025).

The technical complexity and physical demands of gymnastics further compound these challenges. Many skills require advanced coordination, muscular strength, and balance, which can be especially difficult for novices to acquire within limited instructional time. At the same time, teachers must prioritize safety by providing clear demonstrations, accurate feedback, and vigilant supervision. Studies have emphasized that the risk of injury in gymnastics can be heightened when students receive inadequate guidance or attempt skills before achieving sufficient readiness (Farì et al., 2021; Moeskops et al., 2022). When learners repeatedly struggle to master foundational skills, their frustration and perceived incompetence may lead to decreased motivation and disengagement from PE, reinforcing negative attitudes toward gymnastics and physical activity more broadly (Lobo, 2024; Wibowo et al., 2025).

In response to these challenges, digital pedagogy has gained prominence as a promising pathway to enhance engagement, support differentiated learning, and scaffold skill acquisition in PE. Technological tools such as video modeling examples allow students to repeatedly view and analyze movement patterns, thereby supporting self-regulated learning and enabling practice at an individualized pace (Trabelsi et al., 2021). Flipped classroom models, where theoretical or conceptual content is delivered online before in-class practice, have been used to free up instructional time for hands-on skill work in gymnastics, leading to more efficient use of PE sessions and potentially richer learning experiences (Faridah et al., 2022). Such approaches can accommodate diverse learning styles, foster autonomy, and strengthen learners' intrinsic motivation to engage with gymnastics tasks (Huang & Yu, 2022).

Beyond video-based instruction, the integration of e-learning platforms and online resources in gymnastics education has created new opportunities to personalize instruction and extend learning beyond the gymnasium. Well-designed digital materials can offer varied explanations, demonstrations, and practice tasks that align with students' preferences and individual progress trajectories (Ying-hui, 2022). Emerging technologies, including virtual reality and artificial intelligence, are expected to further transform gymnastics teaching by providing interactive practice environments, individualized feedback, and realistic simulations of complex skills (Ren & Ma, 2025; Herlambang et al., 2025). However, these benefits are contingent on teachers' digital competencies and their willingness to adapt traditional pedagogies to leverage technological affordances effectively (Huang & Yu, 2022).

Within this broader turn toward digital pedagogy, the 7E instructional model has emerged as a comprehensive framework to structure learning processes in a wide range of subjects. The 7E model—comprising Engagement, Exploration, Explanation, Elaboration, Evaluation, and Extension—emphasizes active student participation, iterative knowledge construction, and reflective practice. In PE contexts, the Engagement phase is crucial to stimulate interest and activate prior experiences, thereby creating a motivational foundation for subsequent learning (Ghorbel et al., 2024; Ren & Ma, 2025). The Exploration phase encourages learners to investigate tasks through hands-on practice and discovery, a particularly valuable process for motor learning in gymnastics where embodied experimentation and repetition underpin skill refinement (Matsuura et al., 2025; Trabelsi et al., 2021).

Subsequent phases of the 7E model further support deep learning in gymnastics. During Explanation, teachers clarify underlying concepts, techniques, and safety considerations, helping students connect exploratory experiences with explicit knowledge (Faridah et al., 2022). Elaboration then provides opportunities for learners to apply skills in varied situations, thereby strengthening retention and transfer, and has been associated with improved perceptions of physical competence in gymnastics training

(Reguera-López-de-la-Osa et al., 2023). Evaluation involves systematic assessment of performance and understanding, enabling targeted feedback that can motivate learners and guide remedial effort (Anderson et al., 2022). Finally, Extension invites students to apply their skills in broader or novel contexts, reinforcing the relevance of gymnastics to everyday physical activity and promoting sustained engagement beyond formal PE lessons (Zhang et al., 2024). Empirical work suggests that the structured nature of the 7E model can foster enthusiasm and facilitate skill acquisition among novice gymnasts (Petrušič & Novak, 2024; Ren & Ma, 2025).

A growing body of research has combined the 7E framework with multimedia tools to optimize motor learning. Video modeling, digital simulations, and mobile applications have been employed to make gymnastics instruction more interactive and learner-centered. For example, video feedback supports critical self-analysis of performance and promotes self-regulated technique refinement, particularly when students can pause, replay, and compare their execution to expert models (Huang & Yu, 2022; Trabelsi et al., 2021). Blended learning models that integrate online activities with in-person instruction have been shown to accommodate multiple learning styles and increase engagement in PE (Dafun et al., 2024; Faridah et al., 2022). Gamified applications and interactive educational games designed for motor skill development further enhance motivation and enjoyment while supporting cognitive and motor growth (Bouzid et al., 2025; Rymar et al., 2025). Despite these advances, many existing designs do not fully address the need for systematic differentiation and inclusive participation in elementary gymnastics.

Current instructional models for digital or hybrid gymnastics learning remain limited in several respects. First, they often lack sufficient adaptability to heterogeneous student populations with diverse physical and cognitive profiles, an issue that is critical in elementary settings where variability is the norm (Anderson et al., 2022). Second, while digital platforms can increase accessibility and offer varied modalities, they sometimes fail to provide the collaborative, socially rich learning experiences that are central to PE (Ghorbel et al., 2024). Third, existing models frequently prioritize technical execution over higher-order cognitive processes such as decision-making, problem-solving, and reflective thinking, despite evidence that these processes can be effectively supported through technology-enhanced environments (Bouzid et al., 2025). Consequently, there remains a need for an integrative, multimedia-based instructional model that explicitly aligns constructivist principles, multimedia learning theory, and motor learning frameworks to address these gaps.

Against this backdrop, the present study investigates the implementation of a multimedia-based 7E instructional model in elementary gymnastics. By integrating principles of constructivist learning, multimedia learning, and motor learning, the study seeks to provide a structured yet flexible framework that is intended to support student engagement and differentiated skill acquisition in floor gymnastics (Pradipta et al., 2023; Reguera-López-de-la-Osa et al., 2023; Trabelsi et al., 2021). The novelty of this work lies in applying the 7E model—previously established mainly in science and classroom-based learning—to a motor-skill domain in PE, while leveraging digital resources such as video modeling, mobile applications, and interactive tasks. The study aims to examine whether this multimedia-based 7E model is associated with changes in (a) students' engagement across behavioral, cognitive, and affective dimensions and (b) gymnastics performance in an inclusive elementary PE context. In doing so, it addresses a critical gap in the literature and offers empirical evidence to guide the design of future technology-enhanced instructional models in gymnastics and related physical activities.

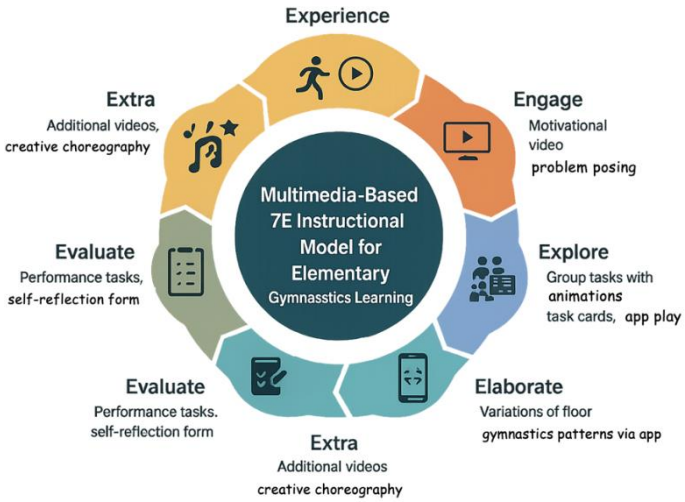
Method

Research Design

This study employed a quantitative quasi-experimental one-group pretest–posttest design to examine changes associated with the implementation of a multimedia-based 7E instructional model in elementary gymnastics learning (Figure 1). Quasi-experimental designs are widely used in educational contexts where intact classes must be preserved and random assignment is not feasible, yet researchers still aim to examine the impact of an intervention (Faridah et al., 2022). All participating classes received the same treatment, and changes in outcomes were analyzed by comparing pre-intervention and post-in-

tervention scores within the same group. Although randomized controlled trials provide stronger evidence of causality (Cardinali et al., 2022; Reguera-López-de-la-Osa et al., 2023), they are often impractical in school settings; accordingly, the present design allows for the observation of pre–post changes but does not permit strong causal inference, and is consistent with current practice in research on multimedia and blended learning in physical education (Faridah et al., 2022).

Figure 1. Conceptual framework of the multimedia-based 7E instructional model for elementary floor-gymnastics learning.



The model depicts seven interconnected phases—Experience, Engage, Explore, Explain, Elaborate, Evaluate, and Extra—each supported by multimedia tools such as video modeling, animations, Android applications, and digital task cards to support student engagement and skill practice. The conceptual framework illustrated in Figure 1 captures the systematic integration of digital pedagogy within the 7E instructional cycle, emphasizing its role in guiding both cognitive and motor-skill development. Situated at the core of this framework is the multimedia-based 7E model that structures learning through sequential, interdependent phases, each leveraging distinct technological affordances to facilitate engagement and understanding during instruction. The diagram reflects how learners transition from activating prior experiences to engaging with multimedia stimuli, exploring tasks collaboratively, and constructing explanations with digital supports before elaborating through application, evaluation, and creative extension. This cyclical structure embodies the constructivist principle of continuous knowledge building and reflection while aligning with motor-learning frameworks that prioritize iterative practice and feedback. The inclusion of diverse digital tools—such as interactive video modeling, mobile applications, and self-reflection instruments—demonstrates the multidimensional nature of the instructional approach, highlighting how technology can scaffold differentiated learning experiences that may contribute to positive changes in gymnastics proficiency across diverse student populations.

Research Subjects

Participants were 100 third-grade students from four public elementary schools in Makassar. Schools were selected based on willingness to collaborate, availability of basic gymnastics facilities, and access to digital devices. Within each school, whole classes were included to maintain ecological validity, provided that parents or guardians gave informed consent and students had no medical contraindications for participation in physical education. The sample size is comparable to previous studies examining instructional models and engagement in PE and was considered adequate to detect moderate pre–post changes (Ghorbel et al., 2024).

Materials and Apparatus

The intervention used a combination of digital and conventional instructional resources. Digital materials comprised an Android-based application containing short animated clips, video modeling examples of specific floor-gymnastics skills (e.g., forward rolls, balances, and simple movement transitions), and

interactive digital task cards. These resources allowed students to observe target movements, receive visual cues, and regulate their own pace of learning, in line with evidence on video modeling and multimedia support in motor learning (Huang & Yu, 2022; Trabelsi et al., 2021; Ying-hui, 2022). Physical materials included PE mats and appropriate floor-gymnastics apparatus, as well as printed worksheets for brief written reflections. Assessment instruments consisted of rubric-based gymnastics skill tests and structured engagement observation sheets.

Sample Preparation

Before the intervention, school leaders and PE teachers were informed about the purpose, procedures, and ethical aspects of the study. Participating teachers attended a workshop introducing the multimedia-based 7E instructional model and the digital tools, echoing recommendations that technology-supported PE should be accompanied by teacher training (Ghorbel et al., 2024). Brief socialization sessions familiarized students with the application and clarified expectations related to safety and participation. Baseline gymnastics skills were then assessed through a pretest.

Experimental Setup

The intervention was implemented over four consecutive weeks during regularly scheduled PE lessons. Each 50-minute session followed the sequence of the 7E instructional model, with multimedia resources embedded in the Engagement, Exploration, Explanation, and Elaboration phases to provide visual demonstrations and task prompts. Evaluation and Extension activities focused on feedback, self-reflection, and the application of learned floor-gymnastics skills in varied movement contexts.

Parameter Measurement

1. Student Engagement

Student engagement was examined from behavioral, cognitive, and affective perspectives. Behavioral engagement was recorded via structured observations using an observation sheet consisting of multiple indicators rated on a four-point scale, focusing on participation, on-task behavior, and responsiveness to teacher instructions (Tarocchi et al., 2024). Cognitive engagement was inferred from students' responses during questioning, the quality of their written reflections, and performance on short quizzes about key concepts and movement principles (Matsuura et al., 2025). Affective engagement—covering enjoyment, interest, and perceived self-confidence—was measured using a brief, age-appropriate questionnaire comprising Likert-type items adapted from validated PE engagement scales (Khataybeh et al., 2024; Zhou & Qi, 2022). Observation items and questionnaire statements were aligned with the phases of the 7E model to allow analysis of engagement across the lesson sequence.

2. Gymnastics Skills

Gymnastics performance focused on specific age-appropriate floor skills, including forward and backward rolls, static and dynamic balances, and simple movement transitions performed in short sequences. Skills were evaluated at pretest and posttest using rubric-based rating scales that captured technique accuracy, body control, and continuity. The criteria drew on existing tools used in gymnastics training research (Cardinali et al., 2022) and were reviewed by experienced PE teachers to ensure content validity and age appropriateness.

Procedures

Data collection followed a common sequence at all sites. At baseline, students completed the gymnastics pretest and affective engagement questionnaire, and teachers carried out initial observations of behavioral and cognitive engagement during a standard gymnastics lesson. The multimedia-based 7E model was then implemented over the four-week period, during which engagement observations were conducted in each session and field notes documented contextual factors that might influence participation. At the end of the intervention, students repeated the skill test and engagement questionnaire under conditions comparable to the pretest. All procedures complied with school safety regulations and ethical principles for research with children.

Data Analysis

Quantitative data were analyzed using descriptive and inferential statistics. Descriptive statistics (means and standard deviations) were calculated for engagement scores and for gymnastics performance at pretest and posttest. To examine pre–post changes associated with the intervention, paired-sample t-tests were conducted on measures of gymnastics skills and engagement dimensions. Assumptions of normality and homogeneity of variance were examined using Shapiro–Wilk and Levene's tests, consistent with practices in intervention research on multimedia instructional models (Reguera-López-de-la-Osa et al., 2023). Statistical significance was set at $p < .05$, and all analyses were performed using SPSS. A multidimensional analytic approach thus captured both performance outcomes and patterns of engagement observed alongside the multimedia-based 7E model(Ghorbel et al., 2024).

Results

Student Engagement Across 7E Phases

Student engagement during the multimedia-based 7E instructional intervention was consistently high across all phases of the learning cycle. Mean engagement scores, calculated from behavioral, cognitive, and affective indicators, exceeded 3.0 on a four-point scale for every phase, indicating that students were generally in the "active" category throughout the lessons. The highest mean scores were observed in Engage (M = 3.17), Explore (M = 3.16), Extra (M = 3.14), and Experience (M = 3.12), while Explain (M = 3.09), Elaborate (M = 3.09), and Evaluate (M = 3.11) also maintained active engagement levels. These findings suggest that students were behaviorally, cognitively, and affectively involved during the instructional sessions, mirroring the multidimensional conception of engagement widely used in physical education research (Bouzid et al., 2025; Reguera-López-de-la-Osa et al., 2023; Ren & Ma, 2025).

Table 1 summarizes the engagement scores and primary activity indicators for each 7E phase. The Experience phase was characterized by recalling and sharing prior gymnastics experiences, carefully following teacher explanations, and performing warm-up activities as initial readiness tasks, all of which supported behavioral and affective engagement. In the Engage and Explore phases, students responded to multimedia demonstrations, identified movements they perceived as easy or difficult, and worked in small groups to interpret graphics and animations before performing prescribed floor patterns. These phases particularly leveraged interactivity, personalization, and collaborative learning, factors shown to foster heightened engagement in multimedia-supported PE settings (Barreto et al., 2023; Brito et al., 2021; Straker et al., 2021).

In the subsequent phases, Explain and Elaborate, students articulated the stages of dominant movement patterns, asked clarifying questions, and collaboratively explored variations of floor gymnastics sequences, indicating sustained cognitive effort and peer-supported reflection. During Evaluate, they combined movements in a performance task and completed self-reflection sheets, reinforcing metacognitive aspects of engagement (Matsuura et al., 2025). Finally, in the Extra phase, students viewed additional instructional videos and created short choreographies as extended applications of learning, activities that align with the emphasis on elaboration and extension in structured learning cycles such as the 7E model (Faridah et al., 2022; Matsuura et al., 2025). Overall, the engagement profile across phases reflects the benefits of multisensory, game-like, and socially interactive digital environments for sustaining motivation in gymnastics learning (Barreto et al., 2023; Brito et al., 2021; Ren & Ma, 2025; Straker et al., 2021).

Table 1. Student Engagement Across 7E Phases

7E Phase	Main Activity Indicators (Summarized)	Mean Score	Category*
Experience	Students recalled and shared prior experiences in floor gymnastics, attentively followed the teacher's explanations, and participated in warm-up activities as initial readiness.	3.12	Active
Engage	Students identified which movements were easy or difficult, responded to the educational video presented, and attempted to imitate demonstrated movements using multimedia guidance.	3.17	Active
Explore	Students formed groups according to the teacher's instructions, observed graphics or animations provided, and collaborated to perform prescribed movement patterns.	3.16	Active
Explain	Students articulated the stages of dominant movement patterns being studied and posed questions to the teacher to deepen their understanding of the activity.	3.09	Active
Elaborate	Students discussed variations of dominant floor gymnastics patterns with peers and collaboratively demonstrated those variations in practice.	3.09	Active
Evaluate	Students performed a combination of movements as a skill demonstration and completed self-reflection sheets to assess their own learning progress.	3.11	Active

Extra	Students observed additional instructional videos assigned by the teacher and created short choreographies based on the video as extended application of learning.	3.14	Active

*Category based on interpretation guidelines for the engagement rubric, where mean scores above 3.0 indicate active engagement.

Gymnastics Skill Development: Pretest–Posttest Analysis

Floor-gymnastics skills were assessed using rubric-based performance tests focusing on technique accuracy, body control, and continuity, consistent with established gymnastics-specific assessment practices (Milosis & Siatras, 2022; Pradipta et al., 2023). Table 2 presents the results of paired-sample t-tests comparing pretest and posttest scores for each participating school. Across all four schools, mean scores increased substantially from pretest to posttest, with gains ranging from approximately 11 to 23 points. At SDN Perumnas Antang III, the mean increased from 46.87 at pretest to 69.91 at posttest ($t = 14.45$, $p < .001$, Cohen's $d = 2.89$, indicating a very large effect). At SD Inpres Kapasa, the mean rose from 50.29 to 67.69 ($t = 14.14$, $p < .001$, $d = 2.83$, very large effect). For SDN Rappocini, scores increased from 55.63 to 72.91 ($t = 11.93$, $p < .001$, $d = 2.38$, very large effect), and at SDN Sudirman I, the mean improved from 58.68 to 73.07 ($t = 10.87$, $p < .001$, $d = 2.17$, very large effect). These results indicate statistically significant and practically meaningful improvements in floor-gymnastics proficiency in all schools.

Table 2. Summary of Pretest–Posttest t-test Results for Gymnastics Skills by School

School	Pretest Mean	Posttest Mean	t-value	p-value	Interpretation
SDN Perumnas Antang III	46.87	69.91	14.45	< .001	Significant improvement
SD Inpres Kapasa	50.29	67.69	14.14	< .001	Significant improvement
SDN Rappocini	55.63	72.91	11.93	< .001	Significant improvement
SDN Sudirman I	58.68	73.07	10.87	< .001	Significant improvement

To provide a more detailed picture of performance changes, Table 3 reports descriptive statistics for each school, including mean, standard deviation, and minimum–maximum scores at pretest and posttest. In every school, the entire distribution shifted upward: lower-bound scores increased markedly, and upper-bound scores approached the maximum scale range. For example, at SDN Perumnas Antang III, pretest scores ranged from 33.75 to 63.21, whereas posttest scores ranged from 58.20 to 80.05. Similar upward shifts were evident at SD Inpres Kapasa (from 47.75–67.03 to 55.28–76.16), SDN Rappocini (from 41.19–69.14 to 59.75–86.09), and SDN Sudirman I (from 45.06–72.44 to 54.89–85.65). The pattern of improvement suggests that performance gains were observed across the score distribution, including among lower-performing students, consistent with prior reports of moderate-to-large effect sizes for well-structured instructional models and multimedia-supported gymnastics training (Ghorbel et al., 2024; Khataybeh et al., 2024; Trabelsi et al., 2021).

Table 3. Descriptive Statistics of Gymnastics Skill Tests (Pretest–Posttest)

School (n = 25 each)	Pretest Mean (SD)	Posttest Mean (SD)	Min–Max (Pre)	Min–Max (Post)
SDN Perumnas Antang III	46.87 (7.52)	69.91 (6.64)	33.75–63.21	58.20–80.05
SD Inpres Kapasa	50.29 (6.16)	67.69 (5.99)	47.75–67.03	55.28–76.16
SDN Rappocini	55.63 (7.44)	72.91 (7.13)	41.19–69.14	59.75–86.09
SDN Sudirman I	58.68 (6.97)	73.07 (6.45)	45.06–72.44	54.89–85.65

Viewed alongside existing evidence on cooperative, blended, and multimedia-based gymnastics instruction, these gains suggest that the multimedia-based 7E model yields pre–post changes comparable in magnitude to other innovative approaches targeting motor-skill acquisition (Faridah et al., 2022; Ghorbel et al., 2024; Khataybeh et al., 2024; Trabelsi et al., 2021). The observed improvements provide empirical evidence supporting the integration of video modeling, personalized pacing, and structured learning phases into elementary gymnastics pedagogy.

Assumption Testing

Prior to conducting inferential analyses, assumption testing was performed to ensure that the use of paired-sample t-tests was appropriate. Normality of the pretest and posttest distributions for each school was examined using both Kolmogorov–Smirnov and Shapiro–Wilk tests, while homogeneity of

variances was assessed through Levene's test. All datasets met the criteria for normality and homogeneity at the conventional significance threshold, confirming that parametric analyses could be applied without violating core assumptions. This aligns with methodological practices in recent intervention studies evaluating multimedia and structured instructional models in PE, where careful assumption testing precedes the use of parametric statistics (Faridah et al., 2022; Reguera-López-de-la-Osa et al., 2023).

Effectiveness Summary

Taken together, the engagement and performance data indicate that the multimedia-based 7E instructional model was associated with favorable engagement levels and substantial pre–post performance gains in the context of elementary floor-gymnastics learning. Active engagement was maintained across all phases, with particularly strong scores in phases that emphasized initial motivation, exploratory practice, and extended application (Engage, Explore, Extra). This pattern is consistent with literature highlighting the importance of interactivity, personalization, gamified challenges, multisensory input, and social interaction for sustaining students' behavioral, cognitive, and affective engagement in digital PE environments (Barreto et al., 2023; Bouzid et al., 2025; Brito et al., 2021; Straker et al., 2021).

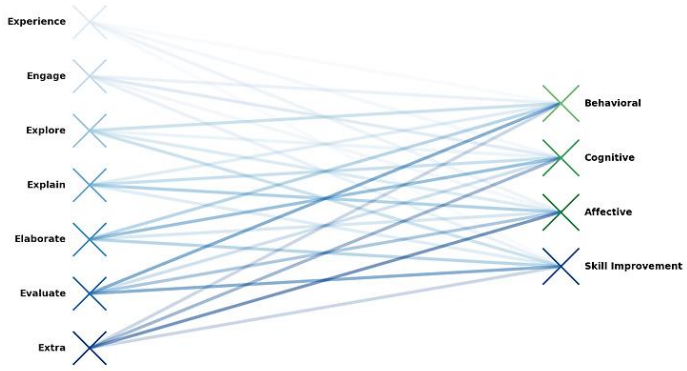
At the same time, substantial pretest–posttest gains in floor-gymnastics skills across all schools suggest that the model supported meaningful skill development alongside engagement. The integration of performance assessments and observational measures—approaches that capture both outcome and process dimensions of learning—is congruent with contemporary recommendations for evaluating motor-skill development in gymnastics (Milosis & Siatras, 2022; Pradipta et al., 2023). Moreover, the structured sequencing of the 7E phases, with deliberate attention to Explanation, Evaluation, and Extension, reflects emerging evidence that such cycles can optimize both understanding and performance in STEM and PE domains (Matsuura et al., 2025; Reguera-López-de-la-Osa et al., 2023).

Overall, the findings from this study corroborate and extend prior research on multimedia-supported and model-based instruction in gymnastics and physical education. The combination of high engagement and robust performance gains suggests that the multimedia-based 7E model represents a promising and scalable framework for enhancing elementary students' skill development and motivation in gymnastics, in line with the broader shift toward technology-enhanced, learner-centered physical education (Bouzid et al., 2025; Ghorbel et al., 2024).

Discussion

The present study found that student engagement remained at an active level across all phases of the multimedia-based 7E instructional model, with particularly high scores in the Engage, Explore, Experience, and Extra phases. This pattern corroborates theoretical and empirical work that conceptualizes engagement as a multidimensional construct encompassing behavioral, cognitive, and affective components (Bouzid et al., 2025; Ren & Ma, 2025). The high engagement observed during the Engage and Explore phases aligns with prior findings in STEM and PE settings, where activities that emphasize curiosity, hands-on exploration, and interactive digital resources have been shown to increase motivation and sustained attention (Barreto et al., 2023; Brito et al., 2021; Straker et al., 2021). In this study, the use of videos, animations, and group-based exploratory tasks appears to be associated with these mechanisms, as reflected in the mean scores for these phases reported in Table 1.

Figure 4. Conceptual linkage between 7E learning phases, multidimensional engagement (behavioral, cognitive, affective), and observed skill improvement.



The strong engagement in the Extra and Experience phases is also noteworthy. In the Experience phase, students recalled prior gymnastics experiences and engaged in structured warm-up activities, which may have activated existing knowledge and contributed to a sense of readiness to learn new skills. Such activation of prior experiences is consistent with constructivist perspectives and with research suggesting that connecting new learning to students' lived experiences can enhance both interest and understanding ((Pradipta et al., 2023). The Extra phase, which involved additional video viewing and choreography creation, extended students' opportunities to apply movement concepts and skills beyond the immediate task, resonating with arguments that elaboration and extension promote deeper processing and longer-term learning (Matsuura et al., 2025; Yoluut et al., 2024; Zhang et al., 2024). These results are consistent with calls for PE curricula that integrate interactive and extended task structures, especially when supported by multimedia resources (Dafun et al., 2024).

Engagement scores in the Explain, Elaborate, and Evaluate phases, while slightly lower than in the initial phases, remained within the active range. This suggests that the cognitive demands of articulating movement principles, experimenting with variations, and conducting self-evaluation were not associated with reduced participation. Rather, these phases may have supported the development of metacognitive and reflective skills, in line with evidence that structured reflection and feedback enhance self-awareness and skill regulation in PE and gymnastics (Petrušič & Novak, 2024). The relatively balanced engagement profile across phases indicates that student involvement was sustained throughout the full learning cycle, not only at the outset when novelty effects might otherwise dominate.

Gymnastics Skill Gains and Comparison with Prior Instructional Models

The substantial pretest–posttest improvements in floor-gymnastics skills across all four schools provide evidence of meaningful performance gains observed alongside the implementation of the multimedia-based 7E model. In each school, mean scores increased significantly, with large t-values and p-values below .001, as summarized in Tables 2 and 3. This magnitude and consistency of improvement are comparable to those reported in previous studies that used blended learning, flipped classrooms, cooperative learning, or video modeling to enhance gymnastics performance (Ghorbel et al., 2024; Khataybeh et al., 2024). For instance, Ghorbel et al. (2024) found moderate-to-large effect sizes when implementing a flipped classroom approach in gymnastics, while Khataybeh et al. (2024) reported significant performance gains using cooperative learning strategies. The present findings suggest that embedding multimedia tools within a coherent 7E structure may be associated with similar levels of improvement, particularly in elementary contexts where scaffolding and repetition are crucial.

The use of rubric-based performance assessments and observational measures echoes existing recommendations for evaluating gymnastics skills in educational settings (Milosis & Siatras, 2022; Pradipta et al., 2023; Ying-hui, 2022). By focusing on technique accuracy, body control, and continuity, the assessment strategy captured both qualitative and quantitative aspects of performance. The upward shift in minimum scores across schools suggests that performance gains were observed not only among higher-performing students but also among those who began with weaker skills. This aligns with the notion that multimedia-enhanced, student-centered instruction can support differentiated learning, allowing

students to progress at their own pace while still benefiting from structured feedback and practice opportunities (Trabelsi et al., 2021; Ying-hui, 2022).

When viewed in light of prior work on instructional effect sizes in gymnastics, the results of this study are consistent with the argument that carefully designed models can be associated with meaningful improvements in motor-skill competence. Studies using video modeling, blended learning, and structured cooperative tasks have all reported significant gains, often with effect sizes in the moderate-to-large range (Ghorbel et al., 2024; Khataybeh et al., 2024). Although effect sizes were not explicitly reported in the present analysis, the pattern of pretest–posttest differences suggests impacts of comparable magnitude. This convergence of evidence underscores the potential of instructional design—particularly when grounded in learning theory and supported by digital resources—to enhance motor-skill learning in PE.

Implications for Teacher Practice and Instructional Planning

The findings of this study have several implications for teachers' instructional planning and day-to-day practice in elementary gymnastics. First, the sustained engagement across 7E phases highlights the value of integrating multimedia resources, such as video modeling and interactive applications, into lesson designs. These tools enable teachers to present complex skills in a visually rich and repeatable format, supporting students' self-regulated learning and allowing them to revisit content as needed (Sari et al., 2022; Trabelsi et al., 2021). In practice, this means that teachers can shift from being the sole source of demonstration to acting as facilitators who guide students in interpreting, practicing, and refining skills using digital supports (Dafun et al., 2024).

Second, the requirement to orchestrate activities across the 7E phases encourages more deliberate instructional planning. Teachers must sequence tasks so that initial engagement naturally leads to exploration, explanation, elaboration, evaluation, and extension, with multimedia resources strategically placed to maximize impact at each stage. Such planning aligns with calls for more student-centered, inquiry-oriented approaches in PE that mirror the structured learning cycles used in STEM education (Faridah et al., 2022; Trabelsi et al., 2021). Implementing this model, however, presupposes that teachers possess sufficient digital literacy and pedagogical design skills to select and adapt resources appropriately (Zhou & Qi, 2022). The results of the present study highlight the importance of ongoing professional development focused on technology integration and model-based instruction in PE.

Third, the positive outcomes observed in this study suggest that multimedia-based 7E instruction may help bridge the gap between diverse student abilities in heterogeneous classrooms. By providing options for repeated viewing, self-paced practice, and varied modes of engagement, the model supports differentiation without necessitating multiple entirely separate lesson plans. This is particularly pertinent in gymnastics, where variations in physical readiness and prior experience are pronounced . Teachers can use digital tools to scaffold learning for less experienced students while simultaneously offering extension activities for those who are more advanced, thereby promoting inclusion and equity in skill development.

Long-Term Motor Learning, Retention, and Social-Cognitive Outcomes

Although the current study focused on short-term pretest–posttest changes, the observed engagement patterns and the structure of the multimedia-based 7E model may have implications for long-term motor learning and retention. Prior research indicates that technology-enhanced environments, particularly those utilizing video modeling and gamified elements, can promote better retention of motor skills by fostering repeated, motivated practice and more accurate mental representations of the movements. The Extra and Extension-type activities in this study may contribute to durable learning by requiring students to reorganize and adapt movement patterns in new contexts (Zhang et al., 2024) .

In addition, the collaborative and reflective components embedded in the 7E phases likely supported social and cognitive outcomes that extend beyond immediate performance gains. Research on digital pedagogy in PE has highlighted how multimedia-supported group tasks can enhance peer interaction, communication, and shared problem-solving, all of which are important for developing a positive learning climate and social skills (Pradipta et al., 2023; Zhang et al., 2024). In this study, activities in the Explore, Elaborate, and Evaluate phases required students to work together, discuss movement strategies, and provide feedback, echoing findings that structured cooperative learning in gymnastics can enhance

both performance and engagement (Khataybeh et al., 2024). While long-term follow-up was not conducted, these process-oriented outcomes suggest a pathway through which the multimedia-based 7E model could influence students' broader attitudes toward physical activity and their willingness to persist in challenging motor tasks.

Limitations, Ethical Considerations, and Transferability from STEM Contexts

Despite the promising results, several limitations and ethical considerations must be acknowledged when interpreting the findings and considering wider implementation. One important limitation concerns the digital divide. The success of the multimedia-based 7E model depends on reliable access to devices and connectivity, which may not be equally available in all schools or communities (Matsuura et al., 2025). Disparities in access could exacerbate existing inequalities in physical education, particularly if technology-rich instruction becomes a prerequisite for high-quality learning experiences. Teachers and policymakers must therefore consider how to provide equitable access to digital resources or design low-tech adaptations that preserve the core principles of the model.

Ethical issues related to privacy and data security also arise when digital tools are used for assessments or when student performances are recorded and stored. Concerns about how personal data are collected, used, and protected are increasingly prominent in discussions of educational technology (Колева et al., 2025). In the context of gymnastics, where video recordings may capture identifiable images of children, strict safeguards and transparent communication with parents and students are essential. Furthermore, educators must ensure that digital content is culturally sensitive and does not reinforce negative stereotypes or unrealistic body ideals, even though specific empirical work on these issues in PE remains limited.

Finally, the broader literature on the 7E model in STEM education offers insights into the transferability of structured learning cycles to PE contexts. Studies in science and mathematics have demonstrated that phases such as Engagement and Exploration are strongly associated with improved conceptual understanding and problem-solving skills (Brito et al., 2021). The present study suggests that analogous benefits can be realized in gymnastics, where active exploration and inquiry-oriented tasks lead to improved performance and enjoyment (Cardinali et al., 2022). Similarly, the Explanation and Elaboration phases appear to play parallel roles across domains by supporting the articulation of underlying principles and the application of knowledge or skills in varied situations (Matsuura et al., 2025; Reguera-López-de-la-Osa et al., 2023). The Evaluation phase, with its emphasis on feedback and self-assessment, fosters self-awareness and regulation in both engineering design tasks and motor-skill development (Petrušič & Novak, 2024).

Although the present study did not directly compare 5E and 7E models, the high engagement and performance gains observed here lend support to arguments from blended and 7E-based interventions in other subjects that more extended learning cycles can offer added value (Faridah et al., 2022). Future research should examine how specific phases contribute to learning in PE and whether certain combinations of digital tools and pedagogical strategies are especially effective for particular skill sets or age groups. Such work would deepen understanding of how insights from STEM education can be systematically adapted to enhance pedagogy in physical education, particularly in resource-constrained contexts where careful design is required to maximize the impact of limited technological infrastructure.

Conclusions

This study found that the implementation of a multimedia-based 7E instructional model was associated with sustained student engagement and improvements in floor-gymnastics performance in elementary physical education. Engagement was sustained at an active level across all phases of the learning cycle, with particularly strong scores in the Engage, Explore, Experience, and Extra phases, indicating that students were behaviorally, cognitively, and affectively involved throughout technology-enhanced lessons. At the same time, substantial and statistically significant pretest–posttest gains in floor-gymnastics skills were observed across all participating schools, suggesting that the model supported skill development alongside engagement. The coherent sequencing of the 7E phases, combined with video modeling, interactive digital resources, and structured opportunities for reflection and feedback, appears to support differentiated learning and may contribute to reducing performance disparities among students.

These findings contribute to the growing body of knowledge on digital pedagogy and model-based instruction in physical education by extending the application of the 7E framework from predominantly STEM domains to a motor-skill context. The results underscore the potential of multimedia-supported learning cycles to address persistent challenges in elementary gymnastics teaching, including heterogeneous abilities, limited instructional time, and the need for safe yet progressive skill development. At the same time, the study highlights important considerations related to teacher digital literacy, access to technology, and ethical issues surrounding data use, which must be addressed to ensure equitable implementation. Future research could examine long-term retention of gymnastics skills, compare 5E and 7E models in PE, and explore low-resource adaptations of multimedia-based instruction to support schools with limited technological infrastructure.

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