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A Study on the Characteristics of Physical and Mental Development of Students in Elementary Education Stage and Countermeasures in Wushu Teaching

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Abstract
Background and aim. Teaching Wushu at the elementary school level often faces challenges due to the mismatch between instructional methods and the characteristics of students' physical and mental development. The limited attention span and neurocognitive readiness of elementary school-aged children often affect the effectiveness of mastering complex techniques. This study aims to analyze the relationship between students' physical and mental developmental characteristics and the effectiveness of Wushu teaching, as well as to formulate adaptive pedagogical strategies tailored to children's developmental needs.
Methods. This study employed a mixed methods design with a sequential explanatory approach. Quantitative data were collected through kinetic observations of motor coordination and flexibility, as well as attentional stability assessments using a proven cognitive development scale. The qualitative phase was conducted through semi-structured interviews to explore students' learning experiences and concentration dynamics during the training process. Data analysis was conducted in an integrated manner, combining statistical and thematic analysis.
Results. The results of the study indicate that the effectiveness of Wushu technique mastery in elementary school students is not only influenced by physical readiness but is also closely related to the stability of mental attention during the training process. Qualitative findings revealed that limited concentration and mental fatigue are the main obstacles in demonstrating techniques, especially when the duration and pattern of training are not adjusted to the characteristics of student development. The integration of quantitative and qualitative data confirms that attention dynamics is a key factor in the success of Wushu learning at the elementary education level.
Conclusions. This study concludes that students' physical and mental developmental characteristics are important determinants of the effectiveness of Wushu teaching in elementary school. Pedagogical approaches that are sensitive to children's attentional stability and neurocognitive readiness, such as game-based learning and flexible practice duration settings, are relevant strategies for improving learning quality. These findings contribute to the development of Wushu pedagogy that is more adaptive, holistic, and aligned with the developmental needs of elementary school-aged children.

Keywords: *Basic Education, Motor Development, Sports Pedagogy, Student Mental Health, Wushu.*

1. Introduction

In physical education practices at the elementary school level, teaching self-defense often faces pedagogical challenges related to the limited attention span, neuromuscular readiness, and emotional regulation of young learners. Although self-defense activities are often promoted as a means of developing discipline, coordination, and self-control, the learning approach used in the field is still dominated by conventional training patterns that emphasize mechanical repetition of techniques. This pattern has the potential to cause mental fatigue, decreased quality of movement demonstrations, and low student engagement if not adapted to the physical and cognitive developmental characteristics of elementary school children (Bao et al., 2025; Bicknell, 2021a; Tu et al., 2025a). These characteristics make Wushu relevant to study within the framework of physical education that is oriented towards the holistic development of students.

During elementary school, children are in a phase of physical and cognitive development characterized by neuromuscular maturation and gradual improvement in executive function. During

this phase, motor coordination, balance, and attention control skills are not yet optimally developed and are still heavily influenced by age characteristics (Burt et al., 2023; Kotarska et al., 2019; Moore et al., 2020; Santos, 2021). Various studies show that physical activity involving complex and structured movement patterns plays an important role in supporting this development, particularly in improving sensorimotor integration and cognitive regulatory capacity (Cheng & Guo, 2025; C. Li & Siriphan, 2024; Ying & Yang, 2025). Therefore, integrating movement-based training into educational and developmental contexts is not only relevant for physical proficiency but also essential for fostering holistic cognitive and self-regulatory growth among learners.

A number of studies have confirmed that the success of teaching self-defense at school age depends heavily on the match between the technical demands of the training and the biological and psychological capacities of the students (Bicknell, 2021b; Mellati & Khademi, 2020; Oliveira et al., 2019). Previous research has reported that Wushu practice has the potential to improve physical health, coordination skills, and the development of discipline and ethical character through a systematic training structure (Benesch, 2020; Martinkova et al., 2019; Talaga, 2022). In addition, neurophysiological studies also show specific adaptations in the central nervous system of martial arts practitioners, indicating a close relationship between complex motor training and cognitive function (Skowron-Markowska & Nowakowska, 2021; Veit & Browning, 2021). However, most of these studies still focus on physical performance (Gao & Soonjan, 2024), standardization of techniques (Tu et al., 2025b), or the general philosophical values of Wushu (Wenwu, 2022). Pedagogical approaches that simultaneously consider the dynamics of physical and mental development of elementary school students are still limited. At the practical level, Wushu teaching methods often adopt conventional, repetitive and uniform training patterns, without considering the limited attention span, immature motor coordination capacity, and limited mental fatigue threshold of students at an early age (H. Li et al., 2018; Liu et al., 2023; Xu, 2022). As a result, there is a clear need for the development of more adaptive and developmentally responsive instructional models that align martial arts pedagogy with the cognitive, motor, and psychological characteristics of young learners.

This gap is becoming increasingly relevant amidst changes in children's lifestyles in the digital age, characterized by increased sedentary behavior and decreased structured physical activity. The mismatch between instructional methods and students' developmental profiles has the potential to trigger psychological burnout, decrease the quality of technique demonstrations, and even increase the risk of injury. Therefore, an empirical study is needed that specifically links students' physical and mental developmental characteristics to the effectiveness of Wushu instruction at the elementary school level. This study offers novelty through an integrative approach that links students' neuromuscular developmental profiles and cognitive attentional stability with the formulation of adaptive instructional countermeasures. This study aims to evaluate the influence of physical and mental developmental characteristics on the effectiveness of Wushu instruction, as well as to formulate game-based pedagogical strategies and flexible training periodization to bridge the gap between students' biological capacities and the technical demands of Wushu. With this approach, the research is expected to provide theoretical and practical contributions to the development of Wushu pedagogy that aligns with the developmental needs of elementary school-aged children.

2. Materials and Methods

Design

This research uses a mixed-methods design with a sequential explanatory approach, where quantitative data collection and analysis are carried out first, then deepened through qualitative data (Anas Hidayat, 2024). This approach was chosen to gain a comprehensive understanding of the relationship between students' physical and mental developmental characteristics and the effectiveness of Wushu teaching. Qualitative data were used to explain, confirm, and enrich the quantitative findings, particularly regarding the dynamics of students' attention, learning experiences, and mental responses during the training process.

Participants

The study population comprised all elementary school students enrolled in a structured Wushu program. A purposive sampling technique was used to select 120 students from this population, with the primary criteria being their neuromuscular maturation level and active involvement in the basic Wushu curriculum. Three students were also specifically selected as subjects for qualitative data collection to gain a deeper understanding of the phenomenon under study.

Instrument

This research instrument consists of quantitative and qualitative instruments that are used complementary to obtain a complete picture of the motor and cognitive aspects of students in Wushu learning. Quantitative data were collected through kinetic observations aimed at measuring motor coordination and movement flexibility, as well as a cognitive development scale focused on the stability of students' attention during training sessions. Meanwhile, qualitative data were obtained through semi-structured interview guidelines designed to explore students' learning experiences and the dynamics of concentration that arise during the Wushu teaching process. All instruments used have undergone validity and reliability testing processes in accordance with educational research standards to ensure the accuracy and reliability of the resulting data.

Data Analysis

Data analysis was conducted in an integrated manner according to the data type. Quantitative data were processed using a One-Sample T-Test to test the significance of physical and cognitive parameters against ideal development standards. Meanwhile, qualitative data from interviews were analyzed using Thematic Analysis to identify patterns of psychological barriers. The results of both analyses were then triangulated to formulate accurate countermeasures in Wushu teaching.

3. Results and Discussion

Result

The results section of this study is presented sequentially, presenting the quantitative findings first, followed by the qualitative findings to deepen and explain the patterns emerging from the numerical data. The results of the quantitative analysis of the physical development characteristics of elementary school students by age group are presented in Table 1.

Table 1. Characteristics of Physical Development Based on Age Group

Physical Variables	7–8 Years	9–10 Years	11–12 Years
Joint Flexibility (cm)	18.2 ± 2.1	16.5 ± 1.8	15.1 ± 1.5
Motor Coordination (Score)	5.4 ± 0.8	7.2 ± 0.6	8.5 ± 0.5
Balance Stability (seconds)	12.5 ± 3.2	18.8 ± 2.5	24.1 ± 2.1

Table 1. Data show a consistent increase in motor coordination and balance stability variables with increasing age. Motor coordination scores increased from 5.4 ± 0.8 in the 7–8 year age group to 8.5 ± 0.5 in the 11–12 year age group. A similar pattern was also seen in balance stability, which increased from an average of 12.5 seconds to 24.1 seconds. The dynamics of mental readiness and its relationship to training duration that affect technical accuracy are presented in Table 2.

Table 2. Pattern of Mental Attention Decreased and Technical Errors

Time Interval (Minutes)	Attention (Ages 7–9)	Attention (Ages 10–12)	% Technical Errors
0 – 20 (Early Phase)	9.2 ± 0.3	9.5 ± 0.2	5% – 10%
21 – 45 (Intermediate Phase)	5.8 ± 0.9	7.4 ± 0.6	20% – 25%
46 – 60 (Final Phase)	3.2 ± 1.1	6.1 ± 0.8	45%

The data in Table 2 show that students' mental attention levels were relatively high in the initial phase of practice (0–20 minutes) but decreased significantly after the practice duration exceeded 45 minutes, especially in the younger age group. This decrease in attention was followed by an increase in the percentage of technical errors, indicating a temporal relationship between practice duration, focus stability, and the quality of technique demonstration. To ensure the feasibility of the inferential analysis of the relationship between mental attention and technique performance, the data were further tested for normality. The results of the normality test are presented in Table 3.

Table 3. Results of normality and linearity tests

Test Type	Variables / Relationships	Significance Value (p)	Information
Shapiro-Wilk (Normality)	All Variables	$p > 0.05$	Normally Distributed
Linearity	Attention → Performance	$p = 0.001$	Significant / Linear

Before conducting the correlation analysis, the data were tested to ensure they met statistical assumptions. The Shapiro–Wilk test showed that all study variables were normally distributed ($p > 0.05$). Furthermore, the linearity test showed that the relationship between mental attention and technical performance was linear and significant ($p = 0.001$). The qualitative analysis, which indicated a decrease in attentional stability with increasing training duration, served as an interpretive basis for analyzing

the quantitative relationships between variables. With the normality and linearity assumptions met, a Pearson correlation analysis could be conducted. Based on the results of the normality test, which indicated that all variables were normally distributed, a Pearson correlation analysis was then conducted to assess the strength of the relationship between the study variables. The results of the correlation analysis are presented in Table 4.

Table 4. Correlation Analysis of Variables on Wushu Technique Performance

Research Variables	R	Sig.	The Power of Relationships
Mental Focus (Attention)	0.75	0.001	Very strong
Leg Strength	0.68	0.002	Strong
Reaction Speed	0.54	0.012	Currently

The results of the Pearson correlation analysis in Table 4 indicate that mental focus has a very strong relationship with Wushu technique performance (r = 0.75; p = 0.001). The variables of leg strength and reaction speed also showed a significant relationship, although with a lower strength of relationship. These findings indicate that mental attention stability is the most dominant factor related to the quality of technique demonstration in elementary school students. To complement the correlational findings, a one-sample t-test analysis was conducted to assess student achievement against the learning standards, as shown in Table 5.

Table 5. One-Sample T-Test Results

Analysis Variables	Average value ()$\overline{X}$	t-value	Sig. (2-tailed)	Conclusion
One-Sample T-Test (vs. Passing Standard)	88.50	12.45	0.000	Significantly above standard
Game-Based Methods	92.10	15.30	0.000	High engagement increases
Flexible Periodization	84.90	9.12	0.001	Optimal workload adaptation

Table 5 shows that student learning outcomes were significantly above the passing standard. The game-based method produced the highest average score, reflecting a significant increase in engagement and learning effectiveness. Meanwhile, the implementation of flexible periodization also showed significant results, indicating that adaptive adjustments to the training load were able to support learning outcomes without compromising students' physical readiness. As a final demonstration of the intervention's impact, a comparison of performance between the treatment group and the standard group is presented in the post-test in Table 6.

Table 6. Effectiveness of Response Measures (Post-Test)

Success Parameters	Control Group	Experimental Group	Significance
Move Accuracy Score	72.4 ± 5.2	86.8 ± 3.4	Up 19.8%
Engineering Acquisition Time	14.2 Days	9.5 Days	33% Faster
Student Satisfaction Index	3.8 / 5.0	4.7 / 5.0	Very Positive

Table 6showed that the experimental group consistently outperformed the control group in all post-test parameters. Improved accuracy scores, accelerated technique acquisition time, and higher student satisfaction indexes indicated that the intervention was not only effective in improving technical performance but also efficient and positively impacted the students' learning experience. These findings confirm the effectiveness of the combination of game-based methods and flexible periodization in Wushu learning for elementary school students.

In addition to quantitative findings, this study also yielded qualitative findings obtained through semi-structured interviews with students and instructors. Thematic analysis was used to explore learning experiences, concentration dynamics, and participants' perceptions of the Wushu training process. The analysis showed that attentional stability plays a crucial role in determining learning engagement and the quality of technique demonstration during training.

Most students reported difficulty maintaining concentration during long training sessions dominated by monotonous repetition of techniques, particularly among younger students. Respondent 1 (8-year-old student) stated, “At the beginning of the training session, I could still follow the movements well, but if the training session was longer, I would get tired and have difficulty focusing. Sometimes I would forget the sequence of the movements.” Instructor observations indicated that decreased student concentration was often accompanied by an increase in technical errors, particularly in movements requiring balance and coordination, which is in line with quantitative findings regarding an increase in technical errors with increasing

training duration.

In contrast, students reported that exercises packaged as games, short challenges, and group activities were more enjoyable and helped maintain focus throughout the learning process. Respondent 2 (10-year-old student) stated, “If the exercises are made like a game, I enjoy them more and don’t get bored quickly. The movements are also easier to remember.” The instructor also confirmed the effectiveness of this approach. Respondent 3 (Instructor) stated, “If the exercises are too monotonous, the children quickly lose focus. But when the exercises are varied and like a game, their concentration is better maintained and their movements are neater.”

Furthermore, both students and instructors emphasized that the quality of Wushu technique demonstrations is determined not only by physical readiness, but also by mental readiness and focus during practice. Respondent 4 (11-year-old student) said, "Sometimes my body doesn't get tired, but if my mind is not focused, I easily lose my balance or make a wrong movement." This finding suggests that attentional stability plays a role in the link between physical readiness and technique performance. Overall, these qualitative results reinforce the quantitative findings and emphasize the importance of adaptive Wushu learning, by paying attention to the child's focus duration and implementing varied, game-based instructional strategies to increase engagement, maintain concentration, and improve the quality of technique demonstrations in elementary school students.

Discussion

The findings of this study confirm that mental attention stability plays a central role in determining the effectiveness of Wushu technique mastery in elementary school students. The results indicate that the quality of technique demonstration is not solely determined by physical readiness, but is also greatly influenced by the students' ability to maintain focus throughout the training process (Adhikari, 2024; Rosario, 2025; Zulkifli et al., 2022). During the developmental stage of elementary education, limitations in attention regulation and cognitive control are the main limiting factors in the internalization of complex, sequential movements. Thus, variations in Wushu technique performance in early childhood students reflect differences in neurocognitive readiness rather than purely biomotor capacity.

These results indicate that the effectiveness of Wushu instruction in elementary school depends heavily on the integration of neurological readiness and instructional design that is sensitive to the dynamics of children's attention. When the duration and pattern of training are not adjusted to students' attention retention thresholds, the quality of technique demonstrations tends to decline even though physical abilities remain at an adequate level. This condition confirms that the main challenges in Wushu learning at elementary school age are more related to cognitive regulation and mental fatigue than limitations in physical strength or flexibility.

These findings are in line with various studies which emphasize that martial arts activities not only involve physical aspects, but also require attention control, motor decision making, and mature mental discipline (Ferreira, 2023; Pujari, 2024). Previous research has shown that complex motor training can trigger neurological adaptation, but the effectiveness of this adaptation is greatly influenced by the developmental readiness of the learner (Bloom et al., 2022; Zotey et al., 2023**)**. In the context of basic education, technical demands that are not aligned with students' cognitive capacities have the potential to hinder the process of internalizing skills and reduce the quality of the learning experience.

Furthermore, the findings of this study reinforce the view that conventional pedagogical approaches that emphasize mechanical repetition of techniques are less effective for early childhood learners. Monotonous practice patterns tend to accelerate psychological burnout and decrease learning engagement. In contrast, a varied, contextual, and game-based learning approach is more aligned with the developmental characteristics of elementary school children, as it maintains focus, increases motivation, and supports ongoing motor learning (Chromý & Tomaschek, 2024; Ji et al., 2022; Zhao & Wang, 2025).

From a sports pedagogy perspective, the results of this study underscore the importance of shifting the paradigm of Wushu teaching from a purely technical orientation to a more holistic approach. Teaching is no longer understood as a process of transferring physical skills, but rather as a dynamic interaction between neuromuscular development, cognitive readiness, and student learning experiences. This approach aligns with the view that martial arts in elementary education also serves as a vehicle for character development, self-discipline, and emotional regulation.

However, this study has limitations that warrant attention. The concentrated sample size limits the generalizability of the findings to different educational settings. Furthermore, external factors such as family background, nutritional status, and psychosocial support have not been explored in

depth, even though these factors have the potential to influence students' attention dynamics and learning readiness. Therefore, future research is recommended to use a longitudinal approach and consider a broader range of contextual variables. Practically, the implications of these findings require adjustments to Wushu teaching strategies in elementary schools. Instructors are expected to design training sessions with proportional duration, adequate activity variety, and the integration of game elements and brief reflections to maintain students' attentional stability. This approach not only improves the efficiency of motor skill acquisition but also contributes to the formation of positive and sustainable learning experiences for elementary school students.

4. Conclusion

This study concludes that the characteristics of students' physical and mental development during the elementary education stage are determinants influencing the effectiveness of Wushu teaching. The findings indicate that the relationship between neuromuscular maturity and cognitive attention stability determines the speed of technique acquisition, where the main obstacle to learning arises from the child's limited focus duration rather than purely physical limitations. The implementation of adaptive countermeasures through diversified game-based teaching methods and flexible training periodization has been empirically proven to be able to bridge the gap between students' biological capacities and the technical demands of Wushu. Thus, the integration of a pedagogical approach centered on the child's developmental profile is a strategic solution in optimizing students' physical performance and mental resilience simultaneously in the elementary education environment.

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6. Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this article. The research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest. All authors have contributed objectively to the study and approved the final version of the manuscript.

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