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Management of Archery-Based Sport Games to Improve Numeracy and Attention in Elementary School Students: A Sequential Exploratory Mixed-Methods Study

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Abstract: Competency-based learning transformation requires the strengthening of numeracy and attention from elementary school through meaningful, safe, and measurable learning experiences. This study aimed to synthesize scientific evidence on the management of archery-based sport games and to verify its practical relevance through primary questionnaire data. A sequential exploratory mixed-methods design was employed. The first phase consisted of a systematic literature review conducted according to the PRISMA guidelines. A Scopus search identified 170 records, which were screened based on publication year, article type, language, access status, primary data orientation, and relevance to archery, target sports, physical education games, attention, and numeracy integration. A total of 25 articles were included in the narrative synthesis. The second phase was conducted using a five-point Likert-scale questionnaire administered to 25 elementary school physical education students who had experience in archery courses. The results showed very high internal consistency, with Cronbach's alpha = 0.945. The overall item mean was 4.47 out of 5, the mean total score was 120.80 out of 135 with SD = 10.81, and 96.74% of responses were categorized as positive. The safety and readiness construct obtained the highest mean score (M = 4.75), followed by attention enhancement (M = 4.49), motivation and engagement (M = 4.49), game-based learning design (M = 4.42), numeracy integration (M = 4.38), and implementation feasibility (M = 4.34). The integration of both findings indicates that archery-based games have the potential to serve as a safe, engaging, and measurable physical education strategy for training focus and embedding contextual numeracy activities. However, claims regarding numeracy improvement still require direct experimental testing with elementary school students.

Keywords: Archery: Games; Gamification; physical education; Numeracy

Introduction

Numeracy ability and attentional capacity are essential prerequisites for elementary school students to understand instructions, monitor errors, and persist in arithmetic tasks that require accuracy. Executive functions, particularly inhibitory control, working memory, and cognitive flexibility, support goal-directed behavior and students' ability to remain focused when dealing with complex tasks (Diamond, 2013). These functions are also closely related to mathematics achievement because students are required to maintain numerical information, suppress irrelevant responses, and shift across problem-solving steps during arithmetic processes (Bull & Lee, 2014; Cragg & Gilmore, 2014). Developmental evidence indicates that mathematics

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anxiety may weaken achievement and attitudes toward mathematics, and may also be influenced by implicit gender stereotypes (Möhring et al., 2024). Therefore, learning designs that activate the body, direct attention, and provide opportunities for numeracy practice within school contexts need to be developed in a more measurable manner.

The relationship among physical activity, cognition, and academic achievement has been widely reported. Systematic reviews have shown positive associations among physical activity, fitness, cognitive function, and academic achievement in children, although the effects vary according to the type, duration, and intensity of activity (Donnelly et al., 2016). A systematic review combined with expert panel recommendations also emphasized that physical activity interventions and academic performance have promising prospects, although stronger causal designs and greater attention to mechanisms of influence remain necessary (Singh et al., 2019). Mechanistic explanations include neurobiological, psychosocial, and behavioral pathways that enable physical activity to support cognitive and mental health among children and adolescents (Lubans et al., 2016). A meta-analysis further showed that cognitively engaging physical activity may enhance executive function in children and adolescents, making attentional control an important foundation for learning (Mao et al., 2024). These findings are consistent with a taxonomy of movement strategies integrated into academic time to strengthen educational outcomes through motor and cognitive engagement (Mavilidi et al., 2022).

In physical education, game management does not merely regulate physical activity. It also organizes goals, rules, feedback, and training rhythm so that student engagement becomes meaningful. Evidence from teachers shows that perceived stress, quality of life, and physical activity levels are related to teachers' capacity to support student self-regulation. Thus, teacher readiness becomes an important factor in movement-based learning innovation (da Silva et al., 2024). Experimental and review evidence indicates that physical activity may support children's executive function when the activity involves coordination, self-monitoring, and cognitive engagement, rather than merely repetitive movement (Best, 2010). The FITKids randomized controlled trial also showed that structured physical activity improved executive control and brain function in preadolescent children (Hillman et al., 2014). In addition, physically active academic lessons have been shown to increase physical activity during learning and may support educational achievement and cognition when movement is deliberately connected to learning objectives (Norris et al., 2020).

Physically active academic lessons provide an important basis for integrating movement and learning. A meta-analysis of physically active classrooms found small positive effects on academic achievement and learning enjoyment compared with traditional sedentary learning (Bedard et al., 2019). Another systematic review showed that classroom-based physical activity interventions may positively influence academic outcomes and physical activity, although implementation quality remains a determining factor (Watson et al., 2017). At the level of learning behavior, classroom-based physical activity programs have been reported to improve students' on-task behavior during academic learning (Mahar et al., 2006). In the context of values and learning climate, traditional games in physical education lectures and practice may become a medium for internalizing prosocial values when rules, roles, and reflection are guided consistently (Kogoya et al., 2023). This framework is relevant for designing archery-based sport games in elementary schools because accuracy, calmness, and procedural discipline require more precise training management than open-ended team games.

The integration of physical activity and numeracy has been supported by intervention evidence. Physically active mathematics and language lessons have been reported to significantly improve academic achievement among elementary school students (Mullender-Wijnsma et al., 2016). The EASY Minds trial demonstrated that integrating physical activity into the elementary mathematics curriculum was feasible and beneficial for mathematics-related outcomes (Riley et al., 2016). From a developmental perspective, early quantitative competence, working memory, and processing speed are predictors of mathematics achievement growth during elementary school (Geary, 2011). A meta-analysis also showed a relationship between physical activity and cognition in children (Sibley & Etnier, 2003), while developmental reviews reported that physical activity may contribute to children's executive function through aerobic and coordinative experimental findings (Best, 2010). Thus, structured physical education learning can be directed to support numeracy when movement tasks, attention, and numerical processing are designed as an integrated learning activity.

Target sports such as archery and shooting require postural control, breath regulation, focus selection, and procedural consistency when performance pressure increases. Among rapid-fire pistol athletes, systematically designed psychological skills training has been associated with changes in psychological indicators and performance, highlighting the importance of targeted cognitive training in precision sports (Jun et al., 2023). Among adolescents, performance anxiety is

related to variations in outcomes and competitive experiences, indicating that training management should include strategies for emotional and attentional regulation (Rossi et al., 2024). Studies in other sport contexts also show relationships among cognitive reappraisal, emotional regulation, and the processing of competitive experiences (Li et al., 2024). In archery, specific physical capacities have been reported to correlate with performance, suggesting that physical and psychological dimensions mutually support accurate shooting (Rusdiawan et al., 2024).

Research mapping on target sports in the last five years tends to move across three clusters. The first cluster concerns physical and technical determinants that predict accuracy. Grip strength and balance have been reported to be related to archery ability, so training is often directed toward strengthening the motor foundation before precision demands are introduced (Prasetyo et al., 2023). The second cluster concerns contextual attentional disturbances, such as levels of nomophobia among athletes that are related to variations in archery accuracy and indicate the influence of distraction outside training (Suhasto et al., 2023). The third cluster appears in studies of petanque shooting techniques that link focus regulation and accuracy as outcomes of repeated practice (Santosa et al., 2024). The success of accuracy training in other precision sports also emphasizes the importance of periodization, feedback, and directed repetition so that accuracy can improve consistently (Anwar et al., 2023). However, most of these studies measure sport performance outputs rather than changes in numeracy and attention within elementary school learning situations.

This gap is also methodological. The development of archery games in elementary schools requires instructional tools, measurement instruments, and consistent evaluation strategies so that benefit claims can be tested. A study on the development of online learning media for big ball games showed that content packaging, activity flow, and evaluation can be integrated into media that guide practice and reflection (Amran, 2023). From a measurement perspective, the adaptation and testing of the PAQ-C model among Indonesian children emphasized the importance of construct validity when physical activity habits are used as prerequisites for a program (Sari et al., 2024). In the computational domain, the development of a physical fitness evaluation system for athletes indicates the direction of data utilization for more objective assessment (Hu & Zulkapri, 2022). A literature review on early childhood sports in Indonesia also showed that evidence mapping remains fragmented, so design decisions are often not yet based on strong synthesis (Ginanjar et al., 2023). Therefore, a research design is needed that does not stop at literature synthesis, but also examines practical feasibility through primary data.

This study was directed toward addressing the research gap that has rarely connected archery game management, attention strengthening, and numeracy integration in elementary school physical education. In addition, this study did not rely solely on literature synthesis, but also used primary questionnaire data to verify the feasibility and practical relevance of the findings. Archery game management in physical education was examined as a strategy to encourage simple arithmetic practice while maintaining attention during activity. The practical relevance of the synthesis was verified through primary questionnaire data from elementary school physical education students who had experience in archery learning. Sport participation is known to contribute to psychological well-being, but these benefits depend on participant experience and the context of sport delivery, including program objectives and structure (Eime et al., 2013). This study aimed to synthesize recent scientific evidence, verify the synthesis themes through primary data, and formulate conceptual-practical implications for developing archery games that integrate attention and numeracy in elementary schools.

Method

This study employed a sequential exploratory mixed-methods design. The first phase was conducted through a systematic literature review to obtain a conceptual and empirical basis regarding archery, target sports, game-based physical education, attention, executive function, and numeracy integration. The second phase was conducted through a questionnaire survey to verify the pedagogical relevance and implementation feasibility of the themes derived from the synthesis among elementary school physical education students who had experience in archery courses. Integration of both phases was conducted using a joint display to compare literature synthesis findings and primary questionnaire data, allowing convergence, complementarity, and implementation implications to be identified systematically (Fetters et al., 2013).

The literature review phase followed the principles of PRISMA 2020 to ensure that the processes of identification, screening, eligibility assessment, and article inclusion were conducted transparently (Page et al., 2021). The search was conducted in the Scopus database using the keywords ("physical education" OR "physical education program" OR "PE") AND ("archery" OR "target sport" OR "precision sport") AND ("primary school" OR "elementary school"). The initial search generated 170 records. After the publication year limit of

2020-2025 was applied, 136 records were obtained. A total of 54 records were excluded because they were not journal articles, leaving 82 articles for screening. After English-language and open-access criteria were applied, 59 articles were assessed for eligibility. The final selection based on primary data, school-context relevance, and connections with archery, target sports, game-based physical education, attention, executive function, motivation, and numeracy integration resulted in 25 articles being included in the synthesis.

Articles were included when they were journal articles, written in English, published between 2020 and 2025, indexed in Scopus, open access, based on primary data, and relevant to archery learning management or game-based physical education. Articles were excluded when they were not relevant to the physical education context, were purely conceptual without pedagogical contribution, were duplicates, had been retracted, or did not provide implications for attention, executive function, motivation, safety, or numeracy integration. Data from the selected articles were extracted based on author, design, intervention, participants, and main findings. The synthesis was conducted narratively and thematically, focusing on six main themes: attention and executive function, game design and gamification, teacher readiness and instructional materials, inclusivity, physical-psychological readiness and safety, and numeracy integration.

The survey phase involved 25 elementary school physical education students who were selected purposively because they had direct experience in archery sport learning. The respondents consisted of 20 male students and 5 female students. Based on semester level, 18 respondents were in semester 2 and 7 respondents were in semester 8. All respondent identities were anonymized before analysis.

The survey instrument used a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. The questionnaire consisted of 27 items grouped into six constructs, namely perceived attention enhancement, numeracy integration, game-based learning design, motivation and engagement, implementation feasibility, and safety and readiness. Content validity was examined by matching each item with the six constructs derived from the literature synthesis. Empirical item validity was tested using Corrected Item-Total Correlation for each construct. An item was considered valid when the corrected item-total correlation coefficient was greater than 0.30. Internal reliability was calculated using Cronbach's alpha.

Questionnaire data were analyzed descriptively using mean, standard deviation, percentage of positive responses, and interpretive categories. Positive responses were defined as scores of 4 or 5. The questionnaire data were complete, with no missing values. The validity test showed that all 27 items met the empirical validity criterion, with Corrected Item-Total Correlation coefficients ranging from 0.371 to 0.923. The overall internal consistency of the instrument was very high, with Cronbach's alpha = 0.945. Alpha values at the construct level ranged from 0.744 to 0.957, indicating that the instrument was adequate for exploratory verification.

Result and Discussion

Result

The results are presented in three parts. The first part presents a thematic summary of the literature synthesis as the exploratory basis. The second part presents the primary questionnaire data. The third part integrates both phases through a joint display.

Thematic Synthesis of the Exploratory Phase

The synthesis of 25 articles showed that archery game management is relevant to six main themes. These themes include attention and executive function, game design and gamification, teacher readiness and instructional materials, physical-psychological readiness and safety, inclusivity, and numeracy integration. The first-phase findings indicate that archery can be positioned as a precision activity that requires focus, self-control, movement stability, emotional regulation, and strict safety procedures. At the same time, the scoring structure in archery provides space for numeracy integration through score addition, result comparison, target zones, and monitoring of learning progress

Table 1. Thematic Summary of Literature Synthesis

Synthesis theme	Main evidence	Implications for archery games
Attention and executive function	Archery and precision sports are related to focus, inhibition, working memory, cognitive flexibility, emotional regulation, and psychological performance strategies (Jun et al., 2023, 2024; Lee & Hwang, 2025; Liu et al., 2023; Wang et al., 2025).	Learning should include focus routines, breath regulation, target locking, response pauses, and shot reflection.
Game design, gamification, and motivation	Game-based learning, gamification, augmented reality, TGfU, Tag-Games, and circuit games improve motivation, engagement, and motor learning outcomes (Astuti et al., 2024; Omarov et al., 2024;	Activities should be designed through missions, levels, training stations, visual scores, and rapid feedback.

Synthesis theme	Main evidence	Implications for archery games
	Qian et al., 2024; Samsudin et al., 2024; Satria et al., 2024; Yachsie, 2023).	
Teacher readiness, instructional materials, and governance	The effectiveness of physical education is influenced by teacher CPD, instructional materials, planning, policy support, and assessment consistency (Komari et al., 2024; Latino et al., 2024; Lee & Cho, 2025; Pratama et al., 2024)	Implementation requires teacher guides, teaching devices, assessment rubrics, and institutional support.
Physical readiness, technique, and safety	Archery accuracy is influenced by core stability, balance, grip strength, physical condition, and drilling structures appropriate to ability levels (Bostanci et al., 2021; Handayani et al., 2024; Khan et al., 2024; Prasetyo et al., 2022; Yachsie, 2023; Yachsie et al., 2024).	Learning should use short distances, safe equipment, simple supporting exercises, and strict supervision.
Inclusivity and value strengthening	Innovative motor curricula and traditional games can strengthen inclusion, engagement, prosocial values, character, and critical thinking (Kogoya et al., 2023; Pradipta et al., 2023; Susanto et al., 2022; Tafuri & Di Palma, 2025).	Targets, tempo, group roles, and peer support should be adapted to student characteristics.
Numeracy integration	Score elements, number of arrows, target zones, score differences, and accumulated achievement provide opportunities for contextual numeracy integration.	Arithmetic activities should be embedded through score recording, result comparison, personal targets, and progress graphs.

Primary Questionnaire Data

Primary data were analyzed to verify the relevance of the synthesized themes to respondents' experiences in archery learning. The analysis focused on six main constructs: perceived attention improvement, numeracy integration, game-based learning design, motivation and engagement, implementation feasibility, and safety and readiness. The mean score for each construct is presented in Figure 1.

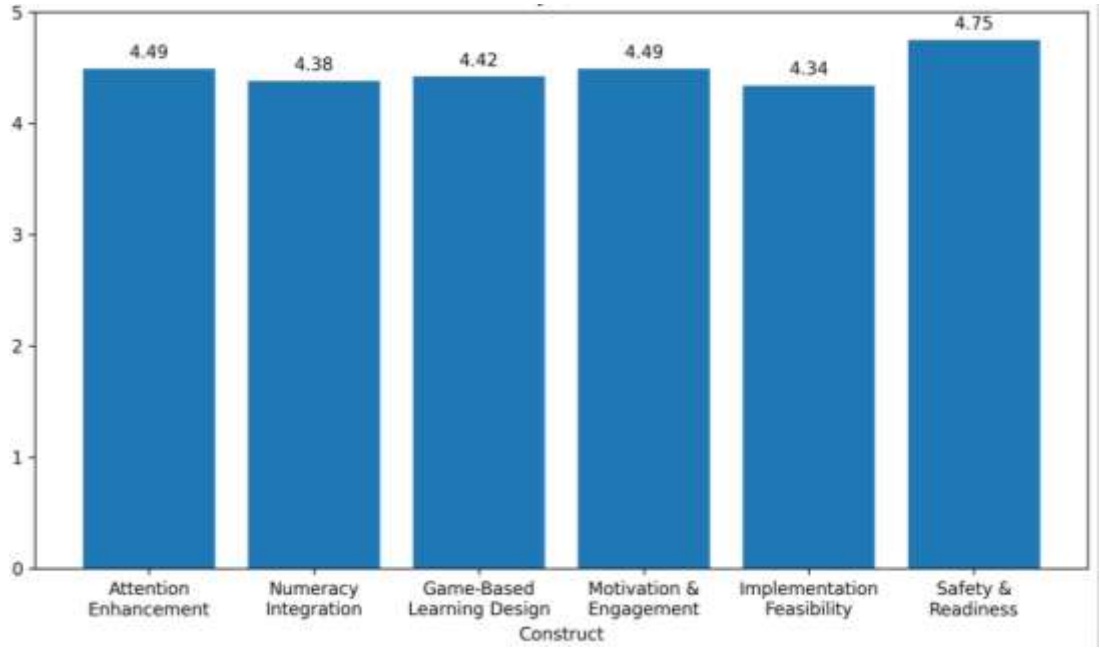

Figure 1. Mean Scores of Primary Questionnaire Constructs

The questionnaire results showed strong support for the potential of archery games as a physical education strategy that integrates attention, numeracy, motivation, game design, implementation feasibility, and safety. The overall item mean was 4.47 on a five-point scale. The mean total score reached 120.80 out of a maximum score of 135, with SD = 10.81. A total of 96.74% of responses were in the positive category. These findings indicate very high acceptance of the idea of archery game management in elementary schools.

Table 2. Respondent Profile

Characteristic	Category	n	%
Gender	Male	20	80.0
Gender	Female	5	20.0
Study program	Elementary School Physical Education	25	100.0
Semester	2	18	72.0
Semester	8	7	28.0

At the construct level, safety and readiness obtained the highest mean score (M = 4.75). The next constructs were perceived attention enhancement (M = 4.49), motivation and engagement (M = 4.49), game-based learning design (M = 4.42), numeracy integration (M = 4.38), and implementation feasibility (M = 4.34). All constructs were in the very high category. This pattern indicates that respondents considered archery games feasible to develop, but still placed safety, supervision, and facility readiness as the main prerequisites.

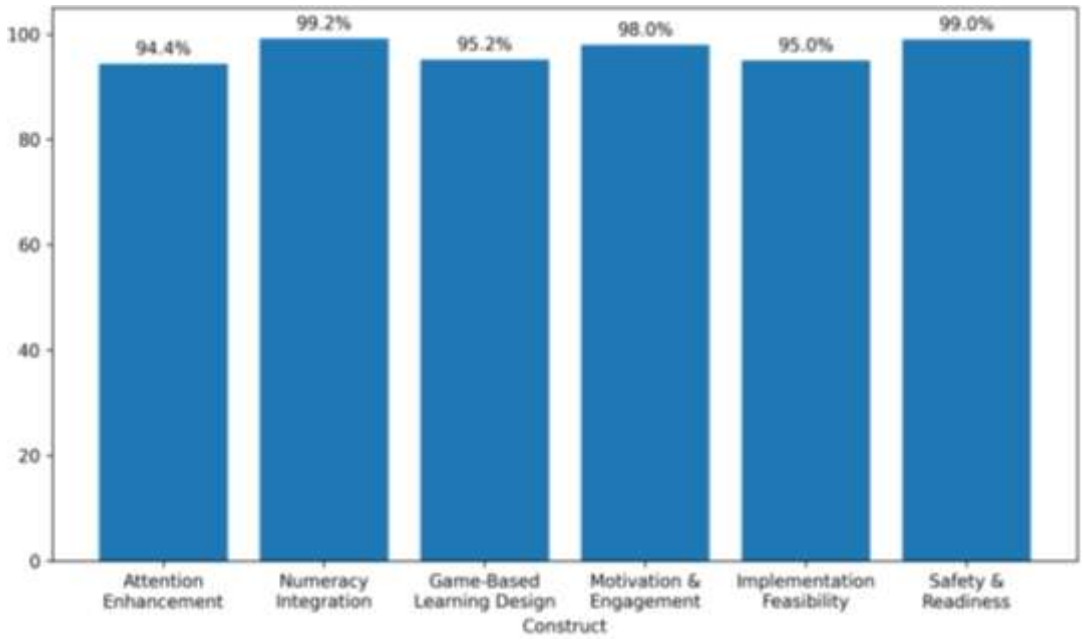

Figure 2. Positive Response Rates by Construct

The percentage of positive responses across all constructs was above 94%. Numeracy integration obtained a positive response rate of 99.2%, while safety and readiness obtained 99.0%. Motivation and engagement obtained 98.0%. Perceived attention enhancement obtained 94.4%, game-based learning design obtained 95.2%, and implementation feasibility obtained 95.0%. These results show that pedagogical aspects, numeracy, motivation, and safety received strong acceptance from respondents.

Instrument Validity and Reliability Test

The item validity test showed that all 27 questionnaire items had Corrected Item-Total Correlation values above 0.30. The coefficients for the perceived attention enhancement construct ranged from 0.850 to 0.923, numeracy integration from 0.649 to 0.778, game-based learning design from 0.371 to 0.626, motivation and engagement from 0.408 to 0.713, implementation feasibility from 0.706 to 0.884, and safety and readiness from 0.461 to 0.798. Thus, all items were declared valid and retained in the analysis

Table 3. Item validity test results

Construct	Number of items	Corrected Item-Total Correlation range	Decision
Perceived attention enhancement	5	0.850-0.923	Valid
Numeracy integration	5	0.649-0.778	Valid
Game-based learning design	5	0.371-0.626	Valid
Motivation and engagement	4	0.408-0.713	Valid
Implementation feasibility	4	0.706-0.884	Valid
Safety and readiness	4	0.461-0.798	Valid

Construct reliability ranged from 0.744 to 0.957. The highest value was found in the perceived attention enhancement construct (α = 0.957), followed by implementation feasibility (α = 0.918), numeracy

integration (α = 0.881), motivation and engagement (α = 0.798), safety and readiness (α = 0.761), and game-based learning design (α = 0.744). All values exceeded the 0.70 threshold, indicating that the internal consistency of each construct was adequate.

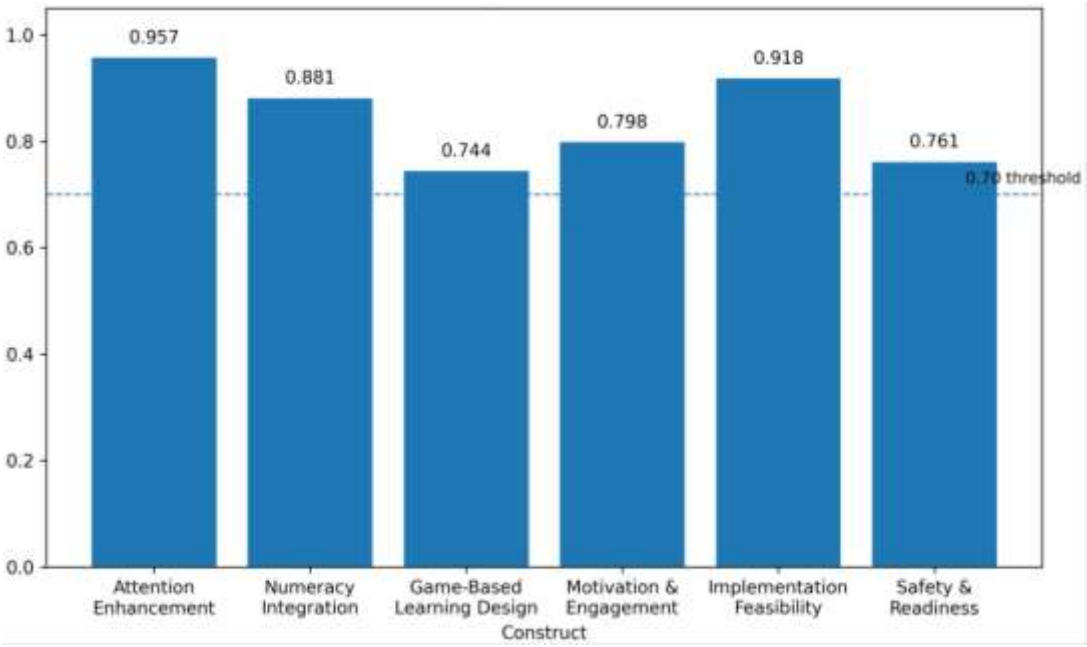

Figure 3. Internal Consistency of Questionnaire Constructs

Table 4. Descriptive results of questionnaire constructs

Construct	Items	Mean/item	SD	Positive responses (%)	Cronbach's alpha	Interpretation
Perceived attention enhancement	5	4.49	0.81	94.4	0.957	Very high
Numeracy integration	5	4.38	0.42	99.2	0.881	Very high
Game-based learning design	5	4.42	0.44	95.2	0.744	Very high
Motivation and engagement	4	4.49	0.42	98.0	0.798	Very high
Implementation feasibility	4	4.34	0.54	95.0	0.918	Very high
Safety and readiness	4	4.75	0.35	99.0	0.761	Very high

Table 5. Integration of literature findings and questionnaire data

Integration theme	Questionnaire results	Integrated interpretation	Implementation implications
Attention and executive function	M = 4.49, positive response = 94.4%	Archery is perceived to require focus, inhibition, calmness, and procedural consistency.	Focus routines, breath regulation, target locking, and shot reflection should be included in learning.
Numeracy integration	M = 4.38, positive response = 99.2%	Activities involving counting arrows, adding scores, and comparing results are considered easy to integrate.	Score tasks, target zones, achievement differences, and progress graphs should be used explicitly.
Game design	M = 4.42, positive response = 95.2%	Missions, levels, station rotation, and rapid feedback support student engagement.	Learning should be packaged as progressive games with simple rules and visual assessment.
Motivation and engagement	M = 4.49, positive response = 98.0%	Target achievement is perceived to build a sense of success and participation.	Realistic targets, group support, and progress reflection should be emphasized.
Implementation feasibility	M = 4.34, positive response = 95.0%	Archery games are considered feasible, but require adaptation for elementary school contexts.	Safe bows, soft arrows, short distances, rotation rules, and teacher guides are required.
Safety and readiness	M = 4.75, positive response = 99.0%	Safety is the main requirement for pedagogical benefits to be achieved.	Safety briefings, shooting-area commands, equipment checks, safe distances, and supervision must be implemented.

The item analysis showed that the highest level of support was given to the statement regarding implementation safety when facilities, rules, and supervision were properly prepared (Item 27, M = 4.88, positive response = 100%). Statements regarding the importance of equipment and practice space (Item 25, M = 4.76), as well as instructor or teacher supervision (Item 26, M = 4.76), also received very high support. In the attention construct, the item stating that archery requires high and sustained concentration obtained a mean score of 4.72. The item with the lowest mean remained in the positive category, namely the feasibility of archery games as an alternative strategy in elementary school physical education (Item 20, M = 4.20, positive response = 88%). These findings indicate strong acceptance accompanied by caution regarding implementation conditions.

Integration of Literature Findings and Questionnaire Data

The integration of the literature phase and questionnaire data showed convergence across all main themes. The literature evidence positions archery as a precision activity that requires attention, self-control, game structure, physical readiness, and safety. The questionnaire data strengthened these themes through very high ratings across all constructs. Numeracy integration also received strong support because archery activities enable students to count arrows, add scores, compare target zones, and monitor personal progress.

Discussion

The mixed-method findings strengthen the argument that archery-based sport games can be positioned as a physical education strategy that involves cognition, rather than merely as a technical sport activity. The synthesis shows that archery and precision sports require sustained attention, inhibition, postural control, and procedural consistency. The questionnaire confirms that students with archery learning experience perceive these attentional demands as very strong. This finding is consistent with meta-analytic evidence showing a positive relationship between physical activity and cognition in children (Sibley & Etnier, 2003), as well as evidence that physical activity can improve executive function, attention, and academic performance among preadolescent children (de Greeff et al., 2018). Systematic review evidence also indicates that physical activity interventions may support cognition and metacognition in children and adolescents (Álvarez-Bueno et al., 2017), as well as several cognitive outcomes in older school-age groups **(Haverkamp et al., 2020)**.

Archery as a physical education game has the characteristics of a precision sport that requires visual focus, postural control, and response inhibition. These characteristics are consistent with selective and sustained attention, which support numeracy learning processes. Experimental evidence shows that a single 45-minute Chinese archery session among preadolescent children improved inhibition, working memory, and cognitive flexibility, as reflected in reaction time and accuracy across three executive function tasks (Liu et al., 2023). In the learning context, attention strengthening can also be facilitated through portable neurofeedback integrated into physical education lessons because such interventions significantly improve attentional performance on the Stroop test (Wang et al., 2025). Evidence from coordinative exercise also shows that brief movement can improve attentional performance when the task requires perceptual-motor regulation (Budde et al., 2008). Therefore, archery game management should combine precision demands with explicitly taught focus strategies.

Primary questionnaire data showed a very high perception of attention enhancement (M = 4.49). This finding supports the interpretation that archery provides opportunities for attentional regulation. However, such benefits cannot be assumed to arise automatically from shooting practice. Research on cognitively engaging physical activity shows that the qualitative characteristics of the task are decisive. Team games that require cognition have been reported to improve shifting more effectively than aerobic exercise alone among elementary school children (Schmidt et al., 2015). Exercise-cognition research also emphasizes the importance of activity quality, such as coordination, decision-making, novelty, and task complexity (Pesce, 2012). Exergame research shows that acute physical activity with cognitive engagement can improve adolescents' executive function (Benzing et al., 2016), while long-term cognitively engaging physical activity breaks can support executive function and mathematics performance (Egger et al., 2019). Thus, archery games for elementary schools should be designed as cognitive-motor tasks that require students to wait for their turn, select targets, calculate scores, monitor errors, and reflect on strategies.

The synthesis and questionnaire data also show that game-based learning design is effective in maintaining engagement and focus, particularly when motor practice has the potential to feel repetitive. Gamification models in physical education have been reported to increase learning motivation and values through the fulfillment of autonomy, competence, and relatedness needs (Qian et al., 2024). When technology is used, augmented reality game-based learning environments increase student activity and motivation compared with traditional methods (Omarov et al., 2024). In non-digital pedagogy, collaboration between

TGfU and Tag-Games makes learning more enjoyable while improving focus and movement skills (Samsudin et al., 2024). A similar pattern appears in game-based physical education, which improves basic manipulative movement skills among elementary school students (Satria et al., 2024). The primary data support this direction because game-based learning design obtained a very high mean score (M = 4.42). Accordingly, archery games should be packaged as progressive challenges with rapid feedback, clear scoring rules, and varied missions so that motivation and attention remain stable throughout the learning unit.

The integration of literature review results and primary questionnaire data shows that numeracy receives strong empirical and conceptual support in the design of archery games. The synthesis indicates that archery inherently contains arithmetic components, while the questionnaire shows very high support for numeracy integration (M = 4.38, positive response = 99.2%). Evidence from physically active academic interventions supports this interpretation. Physically active mathematics and language lessons significantly improve academic achievement in elementary school children (Mullender-Wijnsma et al., 2016). The EASY Minds trial shows that movement integration in the elementary mathematics curriculum is feasible and beneficial for mathematics-related outcomes (Riley et al., 2016). From a developmental perspective, early quantitative competence, working memory, and processing speed predict mathematics achievement growth during elementary school (Geary, 2011). Therefore, archery games can operationalize numeracy through score zones, arrow summation, comparison across shots, differences between target scores and achieved scores, and student progress graphs.

Nevertheless, the questionnaire verified perceptual feasibility, not direct numeracy improvement. This distinction is important because second-phase respondents were elementary school physical education students, not elementary school students taking mathematics tests. These findings strengthen the pedagogical plausibility of numeracy integration, but do not replace the need for experimental evidence. Classroom-based physical activity research shows that physical activity programs can improve on-task behavior during academic learning (Mahar et al., 2006). Physically active academic lessons can also address core educational goals while increasing movement (Bartholomew & Jowers, 2011). A systematic review of classroom-based physical activity interventions showed positive effects on academic-related outcomes, although the heterogeneity of findings confirms that implementation quality remains decisive (Watson et al., 2017). In learning implementation, numeracy components should be designed explicitly through activities such as counting arrows, adding scores, comparing achievements, and reading progress results. Their effectiveness can then be evaluated through pretests and posttests or numeracy performance rubrics appropriate to the developmental level of elementary school students.

The quality of archery game management in elementary schools is strongly determined by teachers' capacity to design objectives, tasks, and assessments according to student characteristics. A 32-week continuing professional development program showed that improved teacher competence was related to higher teaching efficacy, better fitness indicators, and increased student academic achievement. Thus, CPD represents both a pedagogical and health-related investment (Latino et al., 2024). However, in online physical education, teachers reported low effectiveness due to implementation limitations, technological constraints, and weak support for independent learning materials. Studies on e-module needs emphasize the importance of structured and accessible instructional materials so that students can learn independently with clear guidance (Pratama et al., 2024). The questionnaire results confirm this issue because implementation feasibility remained very high but was comparatively the lowest construct (M = 4.34). This indicates that respondents supported archery games, while still emphasizing the need for adapted equipment, safe space, and teacher readiness.

Archery game management must also be sensitive to diverse learning needs, particularly among students with attentional difficulties. Inclusive physical education interventions targeting sensory processing and movement activities among students with ADHD have been shown to improve inclusion and school engagement, while also providing practical strategies for teachers to manage behavioral challenges (Tafuri & Di Palma, 2025). The characteristics of archery, including pauses, impulse control, and simple feedback-based decision-making, are consistent with inhibition components that also improved after an archery session among children (Liu et al., 2023). Attention regulation support through feedback technologies such as neurofeedback may become a differentiation option for students who require additional focus reinforcement (Wang et al., 2025). Peer assistance may reduce distraction without reducing learning autonomy. Therefore, archery in elementary schools should be managed through differentiated targets, tempo, and self-regulation support so that students with varied attentional profiles remain safe, engaged, and able to show meaningful progress.

At the technical level, the effectiveness of archery games is rarely determined by the number of shots

alone. It is more strongly determined by a training structure that develops stability and focus in appropriate doses. Fixed-distance and changing-distance drills both improve accuracy, but fixed-distance drills are more suitable for beginners and adolescents, while changing-distance drills are more relevant for more mature contexts (Yachsie et al., 2024). A six-station circuit game model has been reported to effectively improve balance, concentration, arm muscle endurance, and archery accuracy among young athletes (Yachsie, 2023). Supporting exercises such as circuit plank training also improve arm strength and shooting accuracy at 40 m (Yachsie, 2023). Packaging training stations as small missions enables focus to be maintained without making students easily bored. Therefore, archery game management in elementary schools should prioritize station structure, progressive distance variation, and simple supporting exercises so that accuracy develops together with concentration and movement control.

Safety and physical readiness are prerequisites when archery is positioned as a game for cognitive purposes. A controlled trial among archers showed that pilates combined with balance training over six weeks produced the greatest improvement in lumbopelvic stability and shooting accuracy, thereby clarifying the contribution of core control to precision (Khan et al., 2024). Differences in physical condition across athlete groups also appear in variations of grip strength and static balance, which may influence aiming stability (Handayani et al., 2024). Among children, anthropometric and physical condition mapping supports early identification of archery talent (Prasetyo et al., 2022). The correlation between pulmonary function and shooting scores tends to be weak, so elementary school programs are safer when they emphasize technique, general fitness, and adequate recovery (Bostanci et al., 2021). The strongest construct in the primary questionnaire data was safety and readiness (M = 4.75), confirming that facilities, rules, supervision, and procedures are perceived as absolute requirements for elementary school implementation.

The psychological dimension connects archery activity with attentional outcomes because stable focus is formed through mental skills and situational management. Qualitative analysis of elite archers emphasizes that holistic strategies, including positive mindset, emotional regulation, attentional focus, and environmental coping, form layered processes that maintain score consistency (Lee & Hwang, 2025). Coaches' perspectives show that long-term success is supported by vision, readiness, and reflective self-development commitment (Lee & Cho, 2025). In other precision sports, psychological skills training experiences have shown improvements in field strategies and reductions in competitive anxiety (Jun et al., 2024). Psychological skills training has also been associated with improved brain function indicators and perceived performance confidence (Jun et al., 2023). This evidence strengthens the view that focus should be taught and trained, not assumed to emerge automatically. Therefore, archery management for elementary school students should include brief focus routines, emotional regulation exercises, and simple performance reflection.

The success of archery games is not only determined by activity content, but also by model validity and implementation consistency in the classroom. Development research shows that learning models can be validated systematically through expert panels and Delphi techniques. The Si Buyung gymnastics model met content validity requirements before broader application (Pradipta et al., 2023). A similar development principle appears in traditional sport-based physical education models designed through game-station sequences and assessed as engaging, suitable for student characteristics, and effective for improving character and critical thinking (Susanto et al., 2022). In the elementary school context, the integration of mental training and circuit-based games also improves skill learning outcomes and strengthens motivation (Astuti et al., 2024). The primary questionnaire data strengthen the implementation argument through very high motivation and engagement scores (M = 4.49), but also indicate that subsequent research should validate the archery-numeracy integration model through expert review, limited trials, and direct measurement among students.

Sustainable implementation of archery games in elementary schools requires a governance framework that connects classroom practice with policy, facilities, and community support. A genealogical review of physical education policy emphasizes that program effectiveness depends on a balanced curriculum, appropriate assessment, continuous teacher training, institutional and governmental support, and partnerships with parents and communities (Sumarjono et al., 2024). From the planning perspective, research on physical education teachers shows interaction patterns between length of service and gender that influence the planning of 21st-century skills (Komari et al., 2024). At the operational level, e-module needs indicate that without clear instructional materials, physical education implementation, including game innovation, may easily lose evaluation consistency (Pratama et al., 2024). Such consistency is important because attention and numeracy require repeated practice and progress monitoring. Therefore, archery games should be supported by clear school policies, adequate facilities,

and continuous teacher training so that the program can be adopted, evaluated, and improved systematically.

Thus, the sequential exploratory mixed-methods design strengthens the interpretive validity of this study because themes derived from the literature synthesis were confirmed through primary data. The convergence between literature evidence and questionnaire responses shows that archery games have pedagogical feasibility as a physical education strategy for training attention and integrating numeracy contextually. The first phase identified theoretical and empirical support for attention, game design, safety, and numeracy integration. The second phase confirmed that students with archery learning experience perceived these themes as feasible and pedagogically relevant. The strongest confirmation appeared in safety and readiness, while the relatively lower but still very high implementation feasibility score indicates that the program cannot be recommended without modified equipment, safe distances, clear shooting-area commands, and teacher supervision. Accordingly, the findings provide an initial empirical basis for designing structured archery games as an integrative physical education strategy that combines attention training, contextual numeracy activities, and safety procedures. However, its effectiveness for elementary school students still needs to be tested through direct interventions using standardized measurements of attention, executive function, and numeracy performance.

Conclusion

The results of this study show that archery activities and the characteristics of precision sports, together with game-based physical education strategies, have strong potential to enhance attention and executive function components that conceptually support numeracy. The thematic synthesis identified that archery and related precision games contain visual focus, inhibition, procedural discipline, feedback, and opportunities for score-based learning. The questionnaire phase strengthened these findings through primary data from 25 elementary school physical education students with archery learning experience. Overall questionnaire results were in the very high category (M = 4.47 out of 5, positive response = 96.74%, Cronbach's alpha = 0.945), with the strongest support found in safety and readiness, motivation and engagement, attention enhancement, and numeracy integration. These findings indicate that archery games can be designed as a safe, engaging, and measurable physical education strategy in elementary schools when arrow counting, score accumulation, target-zone comparison, and progress monitoring are incorporated into the game structure. However, this study verified perceptual feasibility and pedagogical relevance, rather than directly testing numeracy improvement among elementary school students. Therefore, future research should develop and validate an archery-numeracy integration model, implement it among elementary school students, and use standardized pretest-posttest measurements of attention, executive function, and mathematics performance.

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Authors Contribution.
H. S: conceptualized the study, developed the research design, conducted the literature search, and drafted the manuscript. W. S and I. G: contributed to article screening, data extraction, and synthesis of findings. D. A. S: contributed to the analysis of numeracy integration and pedagogical implications. M: supervised the study and reviewed the educational relevance of the manuscript. R. P: provided international literature insight, critical revision, and final language refinement. All authors have read and approved the final manuscript.

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