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RESEARCH ARTICLE

Effectiveness of the traditional bentengan game based on local wisdom in improving elementary school students' physical literacy in physical education

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ABSTRACT
The development of physical literacy among elementary school students requires physical education learning that is active, contextual, and capable of integrating physical, affective, cognitive, and engagement-related dimensions. This study aimed to determine the effectiveness of the traditional Bentengan game based on local wisdom in improving the physical literacy of fifth-grade students at SD Negeri Tamalanrea. The study employed a quantitative approach using a quasi-experimental pretest–posttest control group design involving 60 students, consisting of 30 students in the experimental group and 30 students in the control group. Data were collected through motivation and self-confidence questionnaires, physical competence tests, knowledge tests, observations of physical activity engagement, and documentation. The results showed that the mean physical literacy score in the experimental group increased from 62.75 to 76.19, while the control group increased from 61.54 to 66.80. The difference in improvement between the two groups was statistically significant ($p < .001$), with a mean N-Gain of 0.354 in the experimental group and 0.124 in the control group. Greater improvements in the experimental group were also observed across all measured components, including motivation, self-confidence, physical competence, knowledge, and physical activity engagement. These findings indicate that the traditional Bentengan game based on local wisdom is effective as a physical education learning strategy for supporting the multidimensional development of elementary school students' physical literacy.

Keywords: Bentengan; local wisdom; physical literacy; physical education; elementary school.

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INTRODUCTION

Physical literacy is an important foundation of physical education because it involves more than movement skills. It also includes motivation, confidence, knowledge, understanding, and the ability to participate in physical activity throughout life. In children, physical, affective, cognitive, and behavioral dimensions are interrelated (Grauduszus et al., 2023). Schools can support these dimensions through structured movement experiences, and holistic school-based interventions may influence physical literacy, physical activity, and motor competence, although intervention designs vary (Grauduszus et al., 2024; Jerebine et al., 2024). Physical education should therefore provide meaningful and culturally relevant movement experiences rather than focus only on performance.

Despite this multidimensional perspective, physical education practices often emphasize physical performance and motor skills more than motivation, confidence, understanding, and engagement. Reviews have identified inconsistent integration of physical literacy into school programs and a tendency to assess physical outcomes more frequently than cognitive and other domains (Wong, 2022; Anico et al., 2023). Traditional games offer a possible response because they combine movement with play and social interaction familiar to children. Research in elementary schools indicates that traditional games can make physical education more engaging and increase student participation (Fauzi et al., 2024).

Bentengan involves running, changing direction, chasing, evading, defending territory, making decisions, cooperating, and applying game strategies. These activities can stimulate locomotor and other movement patterns, balance, speed, agility, accuracy, and endurance (Arfanda et al., 2024; Riani et al., 2025; Yulianto et al., 2025; Nurhikmah, Akhmady, et al., 2026, pp. 19, 53). Evidence from traditional Lombok games also suggests that culturally rooted games can improve components of physical literacy (Sudarwo et al., 2023). Bentengan may therefore function as an instructional medium integrating physical, cognitive, social, and cultural experiences.

This study examined whether local-wisdom-based Bentengan improves elementary school students' physical literacy. Participants were 60 fifth-grade students at SD Negeri Tamalanrea: 30 in the experimental group and 30 in the control group. A quasi-experimental pretest–posttest control group design was used. Because physical literacy is multidimensional, measurement included questionnaires, physical competence tests, a knowledge test, and observation rather than relying on a single motor-skill indicator (Barnett et al., 2023). The hypothesis was that improvement would differ between the Bentengan group and the control group.

The study's novelty is its examination of Bentengan as a local-wisdom-based intervention for multidimensional physical literacy, rather than as an activity targeting only motor skills, fitness, or character. Earlier studies have discussed traditional games as means of promoting culture, physical activity, character, and social interaction (Hasmarita et al., 2023; Widodo, 2023; Nurhikmah & Maswinatha, 2026). However, the combined assessment of physical, motivational, cognitive, and engagement-related components in a controlled Bentengan intervention remains limited.

Physical literacy connects movement competence with motivation, confidence, knowledge, and continued participation in physical activity. For children, this means that learning should include opportunities to move, make decisions, understand rules, solve movement problems, and interact with peers. Games can provide these experiences within a single activity and offer a broader learning context than isolated skill drills. Accordingly, this study treats physical literacy as a multidimensional outcome encompassing physical skills, understanding, participation, and social experiences.

Previous studies show that traditional games can develop locomotor skills, coordination, balance, agility, and fitness. Research specifically on Bentengan has reported improvements in 60-meter running performance, physical fitness, and locomotor skills, including when the game was combined with values-based learning (Nurhadi et al., 2025; Hilmi & Afifah, 2026; Saprudin et al., 2026; Ulum et al., 2026). These findings support Bentengan's physical-education potential, but they have largely examined individual physical or social outcomes rather than physical literacy as a multidimensional construct.

The research gap concerns the limited evaluation of a specific traditional game across several physical literacy components within one controlled intervention. Studies of traditional games have commonly focused on motor skills, fitness, character, or participation, while intervention structures and assessment approaches remain varied. In Makassar, teachers report using traditional games, although implementation differs according to game selection, teacher perceptions, and practical constraints (Nurliani, 2026). These conditions support the need to test a defined game-based approach using comparable pretest and posttest measurements.

For Bentengan in particular, existing evidence has more often addressed running, fitness, or locomotor skills. It remains necessary to examine whether the game also contributes to motivation, confidence, knowledge, and physical activity engagement when compared with regular instruction. Reviews have similarly noted variation in physical literacy concepts, assessment, and intervention models (Ridha et al., 2025; Rumawatine et al., 2026).

This study addresses the gap by examining Bentengan, local wisdom, physical education, and physical literacy in one quantitative intervention. Local wisdom is understood through the rules, values, practices, and interaction patterns embedded in traditional play. Studies of local-wisdom-based physical education have reported that games such as Baasinan and Balogo can support coordination, agility, strength, and balance. Traditional games can also encourage responsibility, rule compliance, cooperation, and honesty (Hidayati et al., 2021; Miratunnisah, 2024; Nevitaningrum et al., 2023; Rofifah & Roesminingsih, 2023; Satriawan et al., 2023).

Other traditional games, including Tapa Gala, have been associated with mutual cooperation and teamwork in physical education. Such approaches connect movement experiences with students' developmental needs and cultural environments (Nurhikmah & Maswinatha, 2026, pp. 7, 47). Bentengan is therefore considered both a movement activity and a culturally grounded learning experience.

Previous research has used descriptive studies, classroom action research, one-group pretest–posttest designs, mixed methods, and systematic reviews. Although these approaches provide useful information about traditional games, studies without a control group have limited ability to distinguish intervention effects from other influences. The present quasi-experimental pretest–posttest control group design compares change in both groups and uses several data sources to assess physical literacy more broadly.

Bentengan may influence physical literacy through several connected demands. Running, chasing, evading, and changing direction stimulate movement competence; choosing when to attack or defend requires tactical understanding and decision-making; and team play involves communication, cooperation, responsibility, and engagement. Values-based Bentengan research has also reported simultaneous development of locomotor skills and social values (Nurhikmah, Akhmady, et al., 2026, pp. 19, 53). These features provide the conceptual basis for examining the game across multiple physical literacy components. The study tests whether physical education delivered through local-wisdom-based Bentengan produces greater pretest–posttest improvement than the control condition. Outcomes are examined through motivation, self-confidence, physical competence, knowledge, and physical activity engagement.

METHOD

This study employed a quantitative approach using a quasi-experimental pretest–posttest control group design. The design was used to compare changes in physical literacy between the group receiving physical education instruction through the traditional Bentengan game based on local wisdom and the control group. The use of experimental and control groups, both assessed before and after the intervention, made it possible to statistically examine within-group changes as well as between-group differences. The quasi-experimental pretest–posttest control group design was used to evaluate the instructional intervention in the school setting, where the study groups were pre-existing and random assignment was not documented. The study involved 60 fifth-grade students at SD Negeri Tamalanrea, consisting of 30 students in the experimental group and 30 students in the control group. Based on the uploaded research dataset, all students were consistently assigned to either the experimental or control group throughout the pretest and posttest measurements. The specific sampling technique was not stated in the research data and therefore is not assumed in this methodological description.

The independent variable was physical education instruction using the traditional Bentengan game based on local wisdom, whereas the dependent variable was students' physical literacy. The physical literacy construct was operationalized through five

components: motivation, self-confidence, physical competence, knowledge or understanding, and engagement in physical activity. The inclusion of these multiple components is consistent with contemporary approaches that conceptualize physical literacy as a multidimensional construct that cannot be adequately assessed through motor ability alone. Research on the development of physical literacy assessments for school-aged children has shown that motivation and confidence, physical competence, knowledge and understanding, and participation in physical activity represent interrelated components of children's physical literacy assessment (Krenz et al., 2022). A systematic review of physical literacy assessment instruments for school-aged children further emphasized that comprehensive measurement should consider physical, psychological or affective, cognitive, and behavioral domains while also addressing validity, reliability, and feasibility within school settings (Barnett et al., 2023). This multidomain approach is also consistent with reviews of definitions and assessments of physical literacy in children and adolescents, which have identified considerable variation in instruments while retaining a holistic orientation as a central characteristic of the construct (Grauduszus et al., 2023).

Data were collected using four main instruments: a motivation and self-confidence questionnaire, physical competence tests, a knowledge test, and an observation sheet for physical activity engagement, with documentation serving as supporting data. The questionnaire consisted of eight motivation items (M1–M8) and eight self-confidence items (KD1–KD8), using a five-point response scale: 1 = strongly disagree, 2 = disagree, 3 = uncertain, 4 = agree, and 5 = strongly agree. Negatively worded items in the dataset were reverse-scored before component scores were calculated. The use of perceptual indicators covering the psychological domain is consistent with the development of physical literacy instruments for children, as recent instruments also measure psychological dimensions alongside physical, social, and cognitive components in elementary school students (Ortega-Benavent et al., 2024). Validation research on instruments for children aged 4–12 years has likewise emphasized the importance of adapting physical literacy measurement to children's developmental characteristics and population context (Diao et al., 2024).

Physical competence was assessed through six tests included in the research instrument: sprinting, shuttle/agility, throwing and catching, balance, target throwing, and game movement. Each component had a maximum score of 10, after which the total score was converted into a physical competence percentage. The knowledge test consisted of 10 questions, with a score of 1 assigned to a correct answer and 0 to an incorrect answer, and the total number of correct responses was then converted into a percentage knowledge

score. Physical activity engagement was assessed using eight observation indicators (O1–O8) with a four-point scale: 1 = never, 2 = sometimes, 3 = often, and 4 = very often or consistently. The combination of physical testing, motivation and self-confidence measurement, cognitive assessment, and engagement indicators is consistent with multidimensional physical literacy assessment practices among school-aged children. For example, assessments of physical literacy among children aged 8–12 years combine physical competence, motivation and confidence, knowledge and understanding, and physical activity behavior to generate a more comprehensive profile than would be possible using a single indicator (Hadier et al., 2024). CAPL-2-based research among children has also emphasized that these dimensions may be analyzed separately while simultaneously contributing to an overall representation of physical literacy (Blais et al., 2024).

The research procedure began with the administration of a pretest to both groups to establish baseline levels of motivation, self-confidence, physical competence, knowledge, physical activity engagement, and total physical literacy. Following the initial measurement, the experimental group participated in physical education lessons using the traditional Bentengan game based on local wisdom, while the control group received instruction without the Bentengan intervention that constituted the experimental treatment. Based on the implementation sheet in the final research dataset, the Bentengan intervention in the experimental group was conducted over eight sessions on June 8, June 15, June 22, June 29, July 6, July 13, July 20, and July 27, 2026. Each session was observed using eight implementation indicators (K1–K8) with scores ranging from 1 to 4, from not implemented to very well implemented. After completion of the intervention, both groups completed a posttest using the same measurement components as those administered during the pretest. The presence of pre- and post-intervention measurements in both groups made it possible to evaluate changes after the intervention while taking into account the baseline condition of each group. Educational experimental studies using similar configurations commonly employ pretest and posttest comparisons to examine within-group change and outcome differences between experimental and control groups.

The physical literacy score was calculated based on five components contained in the research data recap sheet: motivation, self-confidence, physical competence, knowledge, and physical activity engagement. Each component was expressed as a percentage and assigned an equal weight of 0.20 or 20%, resulting in an overall physical literacy score derived from the weighted combination of the five components. Accordingly, the physical literacy score at each measurement stage was calculated as PL = (0.20 × motivation) + (0.20 × self-

confidence) + (0.20 × physical competence) + (0.20 × knowledge) + (0.20 × physical activity engagement). The use of multiple components to construct an overall score is consistent with the development of physical literacy assessment indices that emphasize a multidimensional structure rather than treating a single physical ability as a proxy for the entire construct (Gao et al., 2024). Nevertheless, each component score was also analyzed separately so that changes in motivation, self-confidence, physical competence, knowledge, and engagement could be examined in addition to changes in the total score.

The data were analyzed using descriptive and inferential statistics. Descriptive statistics were used to present the mean, standard deviation, minimum value, maximum value, and pretest–posttest score changes in both the experimental and control groups. Before hypothesis testing, the data were examined using normality and homogeneity tests to determine whether the assumptions for parametric analysis were satisfied. Subsequently, a paired-samples t-test was used to examine differences between pretest and posttest scores within the experimental and control groups, whereas an independent-samples t-test was used to examine differences in outcomes or improvement between the two groups. The use of an independent t-test in an experimental design with two groups enables researchers to determine whether the difference in group means is greater than the variability that could statistically be expected to occur by chance, provided the required assumptions are satisfied; this analytical approach has also been used in educational research involving experimental and control groups. The significance level was set at $\alpha = .05$, meaning that $p < .05$ was used as the criterion for determining statistical significance.

The effectiveness of improvement was further analyzed using normalized gain, or N-Gain, to indicate the proportion of improvement achieved relative to the maximum possible improvement from the initial score. N-Gain was calculated using the formula (g=(Posttest\ Score-Pretest\ Score)/(Maximum\ Score-Pretest\ Score)). The normalized gain approach has been used in educational research to complement statistical differences by providing an estimate of relative change between pre-instruction and post-instruction conditions, although its interpretation should take baseline scores and data distribution into account (Coletta & Steinert, 2020). In the present study, N-Gain analysis was conducted for changes in physical literacy in both the experimental and control groups and was subsequently compared to provide an indication of the magnitude of relative improvement following the intervention. All conclusions regarding the effectiveness of Bentengan were therefore based on the combined consideration of descriptive statistics, tests of differences, and the magnitude of improvement rather than on a single statistical indicator.

RESULTS AND DISCUSSION

The analysis involved 60 fifth-grade students, consisting of 30 students in the experimental group and 30 students in the control group, based on the data contained in the final research dataset. The physical literacy score was derived from five equally weighted components: motivation, self-confidence, physical competence, knowledge, and physical activity engagement. Descriptive statistical results showed that the mean initial physical literacy score of the experimental group was 62.75 ± 3.63 and increased to 76.19 ± 2.71 at posttest, resulting in a mean improvement of 13.44 points. In the control group, the mean initial score was 61.54 ± 4.45 and increased to 66.80 ± 4.31, with a mean improvement of 5.26 points.

Group	n	Pretest Mean ± SD	Posttest Mean ± SD	Mean Δ
Experimental	30	62.75 ± 3.63	76.19 ± 2.71	13.44
Control	30	61.54 ± 4.45	66.80 ± 4.31	5.26

Table 1. Descriptive Statistics of Physical Literacy Scores by Group

Within the experimental group, the mean motivation score increased from 60.92 ± 4.67 to 68.17 ± 4.50, representing a mean change of 7.25 points. Self-confidence increased from 61.00 ± 5.48 to 68.83 ± 4.86, with a change of 7.83 points. Physical competence increased from 65.17 ± 3.95 to 77.72 ± 3.70, corresponding to an improvement of 12.56 points. The knowledge score increased from 63.67 ± 16.29 to 84.67 ± 12.52, with a mean change of 21.00 points. Physical activity engagement increased from 63.02 ± 5.00 to 81.56 ± 5.02, representing an improvement of 18.54 points.

Component	Experimental Pretest Mean ± SD	Experimental Posttest Mean ± SD	Δ
Motivation	60.92 ± 4.67	68.17 ± 4.50	7.25
Self-confidence	61.00 ± 5.48	68.83 ± 4.86	7.83
Physical competence	65.17 ± 3.95	77.72 ± 3.70	12.56
Knowledge	63.67 ± 16.29	84.67 ± 12.52	21.00
Physical activity engagement	63.02 ± 5.00	81.56 ± 5.02	18.54
Physical literacy	62.75 ± 3.63	76.19 ± 2.71	13.44

Table 2. Experimental Group Component Scores

In the control group, the motivation score changed from 59.50 ± 5.14 to 61.83 ± 5.04, with a mean change of 2.33 points. Self-confidence changed from 59.33 ± 5.83 to 62.33 ± 6.26, with a change of 3.00 points. Physical competence increased from 65.00 ± 4.76 to 69.00 ± 3.52, representing a change of 4.00 points. Knowledge increased from 60.00 ± 19.48 to 68.00 ± 14.24, with a mean change of 8.00 points, whereas physical activity

engagement increased from 63.85 ± 6.90 to 72.81 ± 4.87, representing a change of 8.96 points.

Component	Control Pretest Mean ± SD	Control Posttest Mean ± SD	Δ
Motivation	59.50 ± 5.14	61.83 ± 5.04	2.33
Self-confidence	59.33 ± 5.83	62.33 ± 6.26	3.00
Physical competence	65.00 ± 4.76	69.00 ± 3.52	4.00
Knowledge	60.00 ± 19.48	68.00 ± 14.24	8.00
Physical activity engagement	63.85 ± 6.90	72.81 ± 4.87	8.96
Physical literacy	61.54 ± 4.45	66.80 ± 4.31	5.26

Table 3. Control Group Component Scores

The Shapiro–Wilk test was used to examine the normality of the physical literacy pretest, posttest, change scores, and N-Gain values in each group. In the experimental group, the pretest score yielded W = 0.971, p =.559; the posttest score yielded W = 0.940, p =.091; the change score yielded W = 0.957, p =.265; and the N-Gain score yielded W = 0.937, p =.077. In the control group, the corresponding values were W = 0.957, p =.257 for the pretest; W = 0.949, p =.156 for the posttest; W = 0.959, p =.283 for the change score; and W = 0.937, p =.077 for N-Gain.

Variable	Group	Shapiro–Wilk W	p
PL Pretest	Experimental	0.971	.559
PL Pretest	Control	0.957	.257
PL Posttest	Experimental	0.940	.091
PL Posttest	Control	0.949	.156
Δ PL	Experimental	0.957	.265
Δ PL	Control	0.959	.283
N-Gain	Experimental	0.937	.077
N-Gain	Control	0.937	.077

Table 4. Shapiro-Wilk Normality Test Results

The homogeneity of variance test using Levene's test showed that the pretest scores had F = 2.069 and p =.156, while the change scores in physical literacy produced F = 2.485 and p =.120. The posttest scores yielded F = 5.678 and p =.020, whereas N-Gain yielded F = 4.667 and p =.035. Therefore, between-group comparisons for posttest scores and N-Gain were calculated using Welch's approach because the variances for these variables were not homogeneous.

The paired-samples t-test showed a significant difference between pretest and posttest physical literacy scores in the experimental group, t(29) = 14.901, p <.001. A significant difference was also found in the control group, t(29) = 4.357, p <.001. The experimental group increased by an average of 13.44 points, whereas the control group increased by an average of 5.26 points.

Group	Mean Pre	Mean Post	Mean Δ	t	df	p
Experimental	62.75	76.19	13.44	14.901	29	< .001
Control	61.54	66.80	5.26	4.357	29	< .001

Table 5. Paired-Samples t-Test Results

An independent-samples t-test comparing baseline conditions showed that the pretest physical literacy scores of the experimental and control groups did not differ statistically, t(58) = 1.161, p =.251. At posttest, the experimental group had a mean score of 76.19, whereas the control group had a mean score of 66.80. Welch's test yielded t(48.78) = 10.101, p <.001. The comparison of change scores (posttest–pretest) yielded t(58) = 5.429, p <.001, with a mean change of 13.44 in the experimental group and 5.26 in the control group.

Comparison	Experimental	Control	t	df	p
PL Pretest	62.75	61.54	1.161	58	.251
PL Posttest	76.19	66.80	10.101	48.78	< .001
Δ PL	13.44	5.26	5.429	58	< .001

Table 6. Between-Group Comparison of Physical Literacy Scores

Analysis of score changes by component showed a significant difference in motivation improvement between the experimental and control groups, t = 2.776, p =.007. The difference in self-confidence change yielded t = 2.065, p =.043. The difference in physical competence change yielded t = 5.688, p <.001, while the difference in knowledge change yielded t = 2.371, p =.021. For physical activity engagement, the analysis yielded t = 4.910, p <.001.

Component	Δ Experimental	Δ Control	t	p
Motivation	7.25	2.33	2.776	.007
Self-confidence	7.83	3.00	2.065	.043
Physical competence	12.56	4.00	5.688	< .001
Knowledge	21.00	8.00	2.371	.021
Physical activity engagement	18.54	8.96	4.910	< .001
Physical literacy	13.44	5.26	5.429	< .001

Table 7. Comparison of Score Changes by Physical Literacy Component

The N-Gain analysis showed that the experimental group had a mean N-Gain of 0.354 ± 0.104, with a minimum value of 0.179 and a maximum value of 0.530. The control group had a mean N-Gain of 0.124 ± 0.165, with a minimum value of −0.257 and a maximum value of 0.341. Comparison of N-Gain between the two groups using Welch's test yielded t(48.82) = 6.469, p <.001.

Group	Mean N-Gain	SD	Minimum	Maximum

Experimental	0.354	0.104	0.179	0.530
Control	0.124	0.165	−0.257	0.341

Table 8. N-Gain Scores by Group

The intervention implementation data showed that the Bentengan learning program in the experimental group was conducted over eight sessions. The implementation percentages were 96.88% in the first session, 84.38% in the second session, 93.75% in the third session, 90.63% in the fourth session, 90.63% in the fifth session, 90.63% in the sixth session, 96.88% in the seventh session, and 90.63% in the eighth session. The overall mean implementation rate across all sessions was 91.80%.

Session	Date	Implementation
1	June 8, 2026	96.88%
2	June 15, 2026	84.38%
3	June 22, 2026	93.75%
4	June 29, 2026	90.63%
5	July 6, 2026	90.63%
6	July 13, 2026	90.63%
7	July 20, 2026	96.88%
8	July 27, 2026	90.63%
Mean		91.80%

Table 9. Bentengan Intervention Implementation Across Eight Sessions

The experimental group's mean physical literacy score increased by 13.44 points, compared with 5.26 points in the control group. The groups were not significantly different at baseline, but differed at posttest and in mean improvement (both $p < .001$). This pattern supports an association between Bentengan-based instruction and greater improvement in physical literacy. It is consistent with findings that traditional Lombok games can improve elementary students' physical literacy compared with control instruction (Sudarwo et al., 2023), and with research reporting multidomain benefits from culturally based traditional-game programs (Çinar & Hassani, 2026).

Bentengan combines movement, strategy, cooperation, decision-making, and social interaction. Students repeatedly run, chase, evade, change direction, defend territory, interpret opponents' positions, and coordinate with teammates. These demands provide opportunities to develop movement competence alongside cognitive and social dimensions. This interpretation is consistent with literature describing traditional games as stimuli for motor development and with reviews supporting holistic rather than single-domain physical literacy interventions (Arfanda et al., 2024; Nurhikmah, Akhmady, et al., 2026; Jerebine et al., 2024).

Motivation improved more in the experimental group than in the control group, and the difference was significant ($p = .007$). The game's clear goals, competitive structure, active movement, and peer interaction may help sustain students' interest. This interpretation is consistent with evidence that traditional games can increase elementary students' participation in physical education (Fauzi et al., 2024). The culturally familiar play context may also have made the learning

experience more meaningful, although motivation was measured through student responses rather than direct behavioral measures.

Self-confidence increased more in the experimental group than in the control group ($p = .043$). Bentengan offers different ways to contribute, including running, rescuing teammates, defending the fort, evading opponents, and making tactical decisions. Students can therefore experience success through varied roles rather than through one technical skill alone. Previous research on traditional-game-based physical education has likewise reported improvements in self-confidence, cooperation, and discipline (Supriyanto et al., 2024).

Physical competence improved more in the experimental group than in the control group ($p < .001$). The result is plausible given Bentengan's repeated demands for running, acceleration, stopping, directional changes, coordination, agility, balance, and responses to opponents. Earlier studies have reported improvements in running performance and physical fitness following Bentengan-based activities (Nurhadi et al., 2025; Hilmi & Afifah, 2026). The present result extends this evidence by placing physical competence within a broader physical literacy assessment.

Knowledge showed the largest numerical improvement in the experimental group, with a significant between-group difference ($p = .021$). Bentengan requires students to understand rules, identify attacking and defensive situations, anticipate opponents, and select appropriate actions. Thus, knowledge can be developed through decisions made during play, not only through verbal explanation. Research on traditional-game learning similarly highlights the role of tactical understanding and game-based approaches in supporting cognitive engagement (Nurhikmah, Akhmady, et al., 2026, p. 53; Asykur & Kusumaningrum, 2026).

Physical activity engagement improved more in the experimental group than in the control group ($p < .001$). Bentengan distributes roles across attacking and defending, chasing, evading, and rescuing teammates, giving students repeated reasons to remain involved. This finding is consistent with research reporting that traditional games can increase participation in physical education. Local evidence from Makassar also indicates that teachers use games such as Bentengan, Gobak Sodor, Engklek, Bakiak, and rope jumping to support motivation, cooperation, motor activity, and cultural awareness (Nurliani, 2026).

The mean N-Gain was 0.354 in the experimental group and 0.124 in the control group, with a significant difference ($p < .001$). This indicates a greater proportion of possible improvement in the experimental group. N-Gain should not be interpreted alone; however, its consistency with the posttest comparison and component-level results strengthens the evidence of greater improvement following Bentengan-based instruction. Similar benefits have been reported for traditional-game interventions in elementary physical education (Sudarwo et al., 2023).

Local wisdom is reflected in the rules, teamwork, shared responsibility, and interaction patterns of Bentengan. The game connects movement learning with cultural practices and social values rather than treating physical activity as an isolated exercise. Research on local-wisdom-based

games such as Baasinan and Balogo has identified benefits for physical abilities, while studies of traditional games describe opportunities to practice honesty, responsibility, cooperation, discipline, and mutual assistance (Hidayati et al., 2021; Miratunnisah, 2024; Nevitaningrum et al., 2023; Rofifah & Roesminingsih, 2023; Satriawan et al., 2023).

Implementation fidelity averaged 91.80% across eight sessions, with session scores ranging from 84.38% to 96.88%. This indicates that the intervention was delivered consistently in most sessions. Implementation quality matters when interpreting intervention outcomes because differences in duration, intensity, and delivery can affect results (Jerebine et al., 2024). The fidelity data therefore provide context for interpreting the improvement observed in the experimental group.

The main contribution of this study is its assessment of Bentengan across five physical literacy components rather than through a single physical indicator. The greater improvement in motivation, self-confidence, physical competence, knowledge, and engagement in the experimental group is consistent with a multidimensional understanding of physical literacy. The findings provide an empirical basis for teachers to use traditional games as structured learning strategies, not only as recreation or cultural preservation activities (Çinar & Hassani, 2026; Ridha et al., 2025).

Several limitations should be considered. The study involved 60 fifth-grade students from one school, limiting generalizability to other schools and cultural settings. The intervention lasted eight sessions, and no follow-up measurement was conducted; therefore, the durability of the improvement is unknown. Motivation and self-confidence were self-reported, while engagement was assessed through observation rather than devices such as accelerometers. Variation in physical literacy definitions and instruments also requires caution when comparing these findings with other studies.

The findings suggest that teachers can use Bentengan within a structured physical education program with explicit goals for movement skills, tactical understanding, confidence, cooperation, and active participation. Rules should be adapted to students' age and ability, and teachers need guidance for managing the game safely and inclusively. Because traditional-game implementation in Makassar still faces constraints involving facilities, instructional time, and teacher preparedness, practical teaching guidelines and teacher development may support wider use (Nurliani, 2026). Future studies should involve more schools, longer interventions, follow-up measurements, and objective activity monitoring.

CONCLUSION

The findings demonstrate that the traditional Bentengan game based on local wisdom was effective in improving the physical literacy of fifth-grade students at SD Negeri Tamalanrea. The experimental group showed an increase in the mean physical literacy score

from 62.75 to 76.19, representing an improvement of 13.44 points, while the control group increased from 61.54 to 66.80, representing an improvement of 5.26 points. The difference in improvement between the two groups was statistically significant. Greater improvements in the experimental group were also consistently observed across all measured components, including motivation, self-confidence, physical competence, knowledge, and physical activity engagement. These findings indicate that Bentengan-based learning affected not only students' physical abilities but also the affective, cognitive, and engagement-related dimensions that collectively constitute physical literacy.

Theoretically, this study strengthens the view that physical literacy should be developed through multidimensional and contextual learning experiences. Bentengan provides movement activities combined with decision-making, understanding of rules, cooperation, social interaction, and local cultural values, enabling it to function as a more comprehensive medium for physical education learning. Practically, the findings provide a basis for physical education teachers to incorporate traditional games as part of a structured instructional strategy rather than merely as recreational activities. The high implementation rate across eight sessions also indicates that Bentengan can be systematically integrated into elementary school physical education.

Future research should expand the sample across multiple schools and student populations with different characteristics, employ longer intervention periods, and include follow-up measurements to determine the sustainability of the observed effects. The use of objective instruments to measure physical activity and the continued development of more comprehensive physical literacy assessments may also strengthen the validity of future findings. In addition, variations of Bentengan rules adapted to students' age, ability levels, available facilities, and local cultural characteristics may provide a productive direction for broader implementation of traditional games in elementary school physical education

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DECLARATIONS

Ethical considerations

Not applicable.

Use of artificial intelligence (AI)

The author declares that the generative artificial intelligence (AI) tool ChatGPT (OpenAI) was used exclusively for language editing and/or grammatical improvement. The use of AI did not influence the scientific content, study design, data analysis, data interpretation, results, or conclusions of the manuscript. Full responsibility for the content remains with the author.

Conflict of Interest

The author declares no conflicts of interest.

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