The Scholars Time
A Multidisciplinary Journal of Research and Development
Peer-Reviewed, Refereed, & Indexed Journal
ISSN: 2581-6489

Review Article Open Access

Cognitive Wisdom in Indian Traditional Games: Kancha, Hopscotch and Five Stones through the Lens of Indian Knowledge Systems

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Article Information

Received:	05 March 2026
Accepted:	15 April 2026
Published:	20 April 2026
Volume/Issue/Year:	Vol. 9, Issue 04, 2026, Pages: 04-12
DOI:	https://doi.org/XXXXXXXXXXXXX

How to Cite

Pathak, N., Mander, S. K., & Choudhary, S. (2026). Cognitive Wisdom in Indian Traditional Games: Kancha, Hopscotch and Five Stones through the Lens of Indian Knowledge Systems. *The Scholars Time: A Multidisciplinary Journal of Research and Development*, Volume(9), Issue (04) pages.04-12

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Cognitive Wisdom in Indian Traditional Games: Kancha, Hopscotch and Five Stones through the Lens of Indian Knowledge Systems

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Abstract

Indian traditional games have long been valued as vehicles of holistic development, yet claims about their cognitive benefits have rested almost entirely on observation, oral tradition, and teacher or parent reports. This paper re-examines three widely played Indian games, Kancha (marbles), Hopscotch (Stapu), and Five Stones (Gutte), through the conceptual lens of Indian Knowledge Systems (IKS), specifically the Panchakosha model of holistic development and the yogic principle of dhāraṇā (focused attention). It then tests these traditional claims against empirical evidence from a randomized pretest-posttest control group design involving 90 school children (n = 30 per group) assigned to an Indigenous Games Group, a Digital Games Group, and a Control Group over twelve weeks. Cognitive function was measured with the Span of Attention Test, Digit Span Test, Kohs Block Design Test, and Mental Rotation Test, and brain wave activity was recorded with the Muse 2 EEG headband. Relative to the Control Group, the Indigenous Games Group showed significant gains in Attention, Problem Solving (partial $^2 = .610$), and Spatial Awareness (partial $^2 = .686$), together with significantly higher adjusted Theta and Alpha activity. Indigenous games also significantly exceeded digital games on Attention and Spatial Awareness, but not on Forward Memory. The findings suggest that the cognitive wisdom embedded in these games is specific rather than general, and they support the integration of traditional games into school physical education as envisioned in NEP 2020.

Keywords: Indian Knowledge Systems, traditional games, attention, spatial awareness, EEG, Panchakosha, physical education

1 Introduction

Play in the Indian tradition has never been regarded as idle activity. Games such as Kancha, Hopscotch, and Five Stones were transmitted across generations in courtyards, lanes, and school grounds with no equipment beyond pebbles, chalk lines, and glass marbles. Embedded within their rules are demands on aim, timing, balance, sequencing, and turn-taking that a modern cognitive scientist would recognise as attention, spatial reasoning, and executive control.

The National Education Policy 2020 explicitly calls for the integration of Indian Knowledge Systems into school curricula and for play-based, experiential learning (Ministry of Education, 2020). However, the evidence base for the cognitive value of indigenous games remains weak. Most available studies are descriptive, ethnographic, or based on teacher and parent interviews, and none, to the authors' knowledge, has employed standardized psychological instruments together with neurophysiological measurement to evaluate these games under controlled conditions.

At the same time, children's free time is being rapidly absorbed by screen-based digital

games, which have their own documented, though domain-specific, effects on executive function (Gashaj et al., 2021). The question for Indian educators is therefore not only whether traditional games benefit cognition, but which cognitive functions they benefit and how they compare with the digital alternatives that are displacing them.
This paper has three aims:

1. To articulate the cognitive principles embedded in Kancha, Hopscotch, and Five Stones using IKS frameworks.
2. To present empirical evidence on their effect on cognitive function and brain wave activity in children aged 8 to 12 years.
3. To interpret these findings in terms of their implications for school physical education and the IKS agenda of NEP 2020.

2 Theoretical Lens: Indian Knowledge Systems and the Science of Play

2.1 The Panchakosha Model of Holistic Development

The Taittirīya Upaniṣad describes the human being as composed of five sheaths (kośa): the physical (annamaya), the vital (prāṇamaya), the mental and emotional (manomaya), the intellectual (vijñānamaya), and the blissful (ānandamaya). The National Curriculum Framework for Foundational Stage adopted this Panchakosha model as an organising principle for holistic child development (National Council of Educational Research and Training [NCERT], 2022). From this perspective, a developmentally valuable activity is one that engages several kośas at once rather than training an isolated faculty. Traditional games are close to an ideal expression of this principle. A single round of Hopscotch requires physical balance (annamaya), controlled breathing and energy regulation (prāṇamaya), sustained attention and emotional self-regulation under peer observation (manomaya), rule-based planning and judgement of distance (vijñānamaya), and the intrinsic joy of play (ānandamaya). This integration contrasts with most screen-based games, which engage the intellectual and attentional layers intensively while leaving the physical layer largely inactive.

2.2 Dhāraṇā: Focused Attention in Yogic Thought

In the Yoga Sūtras of Patañjali, dhāraṇā is defined as the binding of the mind to a single place or object (Bryant, 2009). This concept of one-pointed attention has a close behavioural analogue in games that require a child to hold a target in mind while executing a precise motor act. In Five Stones, the child must track a tossed stone in the air while simultaneously picking up stones from the ground; in Kancha, the child must fix visual attention on a distant target marble while calibrating the force of a finger flick. In this sense, traditional games may function as an embodied, playful training ground for dhāraṇā.

2.3 Convergence with Modern Cognitive Theory

These IKS principles converge with established Western developmental theory. Piaget and Inhelder (1969) placed children aged approximately 7 to 11 years in the concrete operational stage, in which reasoning develops most effectively through direct manipulation of physical objects. Vygotsky (1978) argued that rule-governed play creates a zone of proximal development in which children behave beyond their everyday level of self-regulation. More recently, embodied cognition theory has proposed that cognition is grounded in bodily interaction with the physical environment rather than being purely abstract (Wilson, 2002). Diamond and Lee

(2011) further noted that activities combining physical movement, sustained challenge, and social engagement are among the most promising for supporting executive function development in children aged 4 to 12 years. At the neurophysiological level, EEG frequency bands provide a window into these processes. Theta and Alpha oscillations have been linked to memory processes, internally directed attention, and efficient cognitive performance (Klimesch, 1999), whereas Beta activity has been associated with active, externally directed cognitive and emotional processing (Ray & Cole, 1985). These established distinctions provide a framework for asking whether embodied traditional games and screen-based digital games produce different neural signatures.

3 The Cognitive Anatomy of Three Traditional Games

Table 1 maps the core demands of each game onto cognitive functions and Panchakosha layers. This mapping was developed prior to analysis as a theoretical expectation.

Table 1: Cognitive and Panchakosha Demands of Kancha, Hopscotch, and Five Stones

Game	**Core Game Demands**	**Primary Cognitive Functions**	**Dominant Kośa Layers**
Kancha (Marbles)	Aiming at a distant target, estimating force and angle, predicting trajectory, and strategic choice of target	Spatial reasoning, problem solving, focused attention	Annamaya, Vijñānamaya, Manomaya
Hopscotch (Stapu)	Throwing a marker into a numbered grid, hopping on one foot, skipping the marked square, and retrieving the marker while balancing	Spatial awareness, sequencing, motor planning, rule retention	Annamaya, Prāṇamaya, Vijñānamaya
Five Stones (Gutte)	Tossing one stone, picking up others before catching it, progressing through increasingly complex stages	Sustained and divided attention, visual tracking, timing, working memory for stage rules	Manomaya, Annamaya, Vijñānamaya

Three features are common to all three games. First, each requires continuous calibration of the body against real, three-dimensional space. Second, each imposes a sequence of rules that must be retained and followed across turns. Third, each is played socially, so that attention must be sustained while waiting, observing peers, and monitoring fairness. These features lead to the expectation that indigenous games would particularly benefit attention and spatial awareness.

4 Methods

4.1 Design and Participants

The study employed a Randomized Pretest-Posttest Control Group Design. A total of 90 school children aged 8 to 12 years were selected through simple random sampling (random chit method) and assigned to three groups of 30 each:

- Indigenous Games Group: Students of Kendriya Vidyalaya Ghudda, who played Five Stones, Hopscotch, and Kancha.

- Digital Games Group: Students of Kendriya Vidyalaya Ghudda, who played puzzle games, Geometry Dash, and shooting games.

- Control Group: Students from a separate school, who received no game-based intervention. Placement in a separate school was a deliberate methodological safeguard against contamination between the intervention and control conditions.

The intervention was administered over twelve weeks

4.2 Instruments

Table 2: Variables and Measurement Tools

Variable	**Tool**
Attention	Span of Attention Test
Forward Memory and Backwards Memory	Digit Span Test
Problem Solving	Kohs Block Design Test (Kohs, 1923)
Spatial Awareness	Mental Rotation Test (Vandenberg & Kuse, 1978)
Brain Wave Activity (Delta, Theta, Alpha, Beta, Gamma, Total)	Muse 2 EEG Headband

The Muse 2 is a portable four-channel EEG device whose usefulness for research has been supported by validation work against research-grade systems (Krigolson et al., 2017). EEG was recorded at pretest and posttest.

4.3 Statistical Analysis

Normality was assessed with the Shapiro-Wilk test. Variables meeting the normality assumption (EEG bands, Problem Solving, and Spatial Awareness) were analysed with one-way ANCOVA, using the pretest score as the covariate, followed by pairwise comparisons of adjusted means. Forward Memory, Backward Memory, and Attention violated normality and were analysed with the Kruskal-Wallis H test on change scores, followed by Dunn's post-hoc test with Bonferroni correction. Effect sizes are interpreted using Cohen's (1988) benchmarks for partial η^2 (small = .01, medium = .06, large = .14).

5 Results

5.1 Cognitive Function

Table 3: Adjusted Post-Test Means and Group Comparisons for Problem Solving and Spatial Awareness (ANCOVA)

Variable	**Indig.**	**Digital**	**Control**	**F(2, 86)**	**P**	**Partial η_p^2**	**Indig. vs Control (p)**	**Indig. vs Digital (p)**
Problem Solving	10.58	10.21	6.55	67.40	$< .001$	.610	$< .001$	.342
Spatial Awareness	9.71	8.79	5.61	93.93	$< .001$	.686	$< .001$	**.003**

Note. Values in bold are significant at $p < .05$.

Both variables showed large treatment effects. For Problem Solving, indigenous and digital games were equally effective and both exceeded the Control Group. For Spatial Awareness, the Indigenous Games Group showed the highest adjusted mean and significantly outperformed both the Digital Games Group and the Control Group. Spatial Awareness also recorded the largest effect size in the entire study.

Table 4: Kruskal-Wallis H Test on Change Scores for Memory and Attention

Variable	**Indigenous Mean Rank**	**Digital Mean Rank**	**Control Mean Rank**	**H(2)**	**p**
Forward Memory	34.33	61.97	40.20	20.67	$< .001$
Backward Memory	45.08	51.15	40.27	3.10	.212
Attention	59.32	41.18	36.00	14.82	**.001**

Note. Values in bold are significant at $p < .05$.

Dunn's post-hoc comparisons showed that the Indigenous Games Group improved significantly more in Attention than both the Control Group ($p < .001$) and the Digital Games Group ($p = .013$). For Forward Memory, however, the pattern reversed: the Digital Games Group improved significantly more than the Indigenous Games Group ($p < .001$), and the Indigenous Games Group did not differ from the Control Group ($p = 1.000$). No group differences emerged for Backward Memory.

5.2 Brain Wave Activity

ANCOVA revealed significant treatment effects for Theta, $F(2, 86) = 5.77$, $p = .004$, partial $^2 = .118$, and Alpha, $F(2, 86) = 4.04$, $p = .021$, partial $^2 = .086$, both medium effects. The Indigenous Games Group recorded the highest adjusted means for both bands (Theta = 16.82; Alpha = 15.66) and differed significantly from the Control Group (Theta: $p = .001$; Alpha: $p = .006$). The Indigenous Games Group also showed significantly higher adjusted Total Brain Wave activity than the Control Group ($p = .014$). In contrast, the Digital Games Group's most distinctive signature was in the Beta band, where it significantly exceeded the Control Group ($p < .001$). Differences between the two intervention groups did not reach significance on any EEG band.

Table 5: Summary of the Indigenous Games Group's Effects

Domain	**vs Control Group**	**vs Digital Games Group**
Attention	Significant advantage	Significant advantage
Spatial Awareness	Significant advantage	Significant advantage
Problem Solving	Significant advantage	No difference
Forward Memory	No difference	Significant disadvantage
Backward Memory	No difference	No difference
Theta and Alpha	Significant advantage	No significant difference

6 Discussion

6.1 Specific, Not General, Cognitive Wisdom

The most important finding of this study is that the cognitive benefits of traditional games are specific. Indigenous games did not improve every cognitive function; they produced their strongest effects precisely in the domains that their structure would predict, namely attention and spatial awareness, while showing no advantage in forward memory. This selective pattern is scientifically more persuasive than a uniform advantage would have been, because it suggests a plausible mechanism rather than a general enthusiasm or novelty effect.

6.2 Spatial Awareness: The Body as a Measuring Instrument

The large advantage of indigenous games in Spatial Awareness (partial $^2 = .686$), including a significant advantage over digital games, aligns with the embodied cognition perspective (Wilson, 2002). In Hopscotch, the child must throw a marker to a specific square and then traverse the grid on one foot, skipping that square. In Kancha, the child must judge distance, angle, and force to strike a target marble. In both cases, spatial judgement is not merely seen but enacted and immediately verified by physical success or failure. Screen-based games present spatial information on a two-dimensional surface and rarely require whole-body calibration. Training studies have shown that spatial skills are malleable (Uttal et al., 2013); the present findings suggest that embodied, three-dimensional spatial practice may be a particularly efficient route to that malleability in middle childhood. From an IKS perspective, this reflects the integration of the annamaya and vijñānamaya layers: the intellect learns space through the body.

6.3 Attention: Play as Embodied Dhāraṇā

The significant advantage of indigenous games in Attention, over both the Control and Digital Games Groups, lends empirical support to the interpretation of Five Stones and Kancha as forms of embodied dhāraṇā. Five Stones in particular demands that attention be held on a tossed stone while the hands execute a second task within a fraction of a second, and its staged progression requires children to remember which round they are on. Notably, the Digital Games Group, despite intensive visual engagement, did not differ from the Control Group on Attention. This suggests that the fast, externally driven stimulation of screens may train reactive responding rather than the self-directed, sustained attention that traditional games cultivate.

6.4 The Neural Signature: Theta and Alpha

The EEG results are consistent with the behavioural findings. The Indigenous Games Group showed elevated Theta and Alpha activity, bands linked in the literature to internally directed attention, memory processes, and efficient cognitive functioning (Klimesch, 1999). The Digital Games Group, by contrast, was distinguished by Beta activity, which has been associated with externally directed, alert processing (Ray & Cole, 1985). This differentiation offers a neurophysiological counterpart to the IKS distinction between a settled, focused mind and an agitated, outward-scattered mind. It must be emphasised, however, that the two intervention groups did not differ significantly from each other on any single EEG band; the distinction lies in how each differed from the Control Group.

6.5 What Indigenous Games Did Not Do

Intellectual honesty requires acknowledging that indigenous games did not improve Forward Memory relative to the Control Group, whereas digital games did. The rapid, sequential stimulus-response demands of digital games may train the short-term retention and reproduction of sequences more directly. Similarly, indigenous and digital games were equally effective for Problem Solving. These results argue against a romantic view in which traditional games are superior in every respect, and in favour of a balanced, evidence-based integration.

7 Implications for Physical Education and NEP 2020

1. Curricular placement: Kancha, Hopscotch, and Five Stones should be positioned within school physical education as structured cognitive interventions, not merely as cultural or recreational activities.

2. Targeted use: Where the educational goal is attention and spatial reasoning, both foundational for mathematics, geometry, and reading, indigenous games are the stronger choice on the present evidence.

3. Low cost, high access: These games require negligible equipment and no electricity or devices, making them especially suitable for rural and resource-limited Indian schools.

4. Balanced pedagogy: Digital games retained a distinctive benefit for Forward Memory. A balanced programme drawing on both, as envisioned by NEP 2020, is more defensible than an exclusive reliance on either.

5. IKS with evidence: The study demonstrates that IKS-based claims can and should be tested with standardized instruments and neurophysiological tools, strengthening the credibility of IKS integration in education.

8 Limitations

Several limitations should be noted. The Muse 2 has fewer electrodes than research-grade EEG systems and is sensitive to movement artefacts, although recordings were taken at rest before and after the intervention. The assumption of homogeneity of regression slopes was violated for Problem Solving and Spatial Awareness, so these ANCOVA results should be interpreted with appropriate caution. The Control Group was drawn from a separate school, which prevented contamination but may introduce school-level differences. Finally, the sample was limited to 90 children from one region, and the three indigenous games were played as a combined package, so the unique contribution of each game cannot be isolated.

9 Conclusion

Kancha, Hopscotch, and Five Stones carry a cognitive wisdom that Indian tradition has long recognised intuitively and that can now be demonstrated empirically. In this study, these games produced large improvements in spatial awareness and problem solving, a distinctive advantage in attention over digital games, and an associated increase in Theta and Alpha brain wave activity. Viewed through the Panchakosha model, their strength lies in engaging the body, breath, mind, and intellect together in joyful, rule-governed play. Preserving these games in school physical education is therefore not only an act of cultural continuity but a scientifically grounded investment in children's cognitive development.

Acknowledgements

None

Conflict of Interest

The authors declare that there is no conflict of interest associated with this article.

Use of Artificial Intelligence

The authors declare that artificial intelligence tools were used for language improvement and/or formatting assistance. The authors take full responsibility for the originality, accuracy, interpretation, and final content of the article.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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