

Effectiveness of Integrating Vedic Educational Principles on Learning Outcomes in Biology of Secondary School Students of Odisha

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Abstract

Biology instruction in Indian schools is mostly based upon rote-learning, which hinders holistic learning and conceptual understanding among learners. National Education Policy (NEP) 2020 mandates incorporating Indian Knowledge Systems (IKS) in a scientifically validated manner in school curricula. However, the pedagogical practices followed in classrooms still need exploration. Hence, the present study aimed to explore the effectiveness of integrating Vedic and Ayurvedic education in learning biology and then its effect on students' academic achievement. A quasi-experimental single-group pretest-post-test design was used with 30 students, studying in class 8 in a Central Board of Secondary Education (CBSE) affiliated school in Bhubaneswar, Odisha. A biology achievement test (BAT), developed by the researcher containing 50 marks, was conducted before and after the intervention of six sessions (2 weeks). The sessions of 40 minutes each were conducted with the help of a 5E model (Engage, Explore, Explain, Elaborate, Evaluate) lesson plan prepared for a specific chapter which included Vedic pedagogical concepts like Shravana, Manana, Nidhidhyasana, Pratyakshya, Yukti, Shastrath, and Abhyas. A two-tailed paired-samples t-test (SPSS) was applied for analyzing the data. The result revealed that the student's BAT scores improved significantly from pretest ($M = 23.33$, $SD = 11.06$) to post-test ($M = 32.63$, $SD = 8.99$), $t(29) = -9.52$, $p < .001$ with a very large effect size (Cohen's $d = 1.74$). The reduction in the scores' variability reflects that lower achieving students received more benefits from the intervention. Thus, the study concluded that there is a pedagogical, cultural, and policy-level significance in integrating IKS with the teaching of science. The study also provided a feasible model for effective implementation at the level of middle schools in accordance with NEP 2020.

Keywords: Vedic education; Indian Knowledge Systems; NEP 2020; biology achievement; 5E instructional model; Shravana; Manana; Nidhidhyasana; Pratyakshya; Yukti; Shastrath; Abhyas

1. Introduction

Biology is a foundational secondary-school discipline that provides the understanding of life at the molecular, cellular, systemic and ecological levels (Campbell et al., 2020). However, there is a widespread tendency in India to memorize biology-related information for the examination instead of building an in-depth understanding and applying knowledge to real life. The Central Board of Secondary Education and the National Curriculum Framework (NCF, 2023) have both called for a shift away from surface-level recall towards inquiry and application; however, the practical implementation remains insufficient due large class size , exam stress, and a lack of qualified teachers (National Education Policy [NEP], 2020).

India's traditional knowledge systems could benefit in many ways from this reform, and Vedic and Ayurvedic concepts related to biology, such as the Garbha (embryo), Srishti (reproduction), Bija (seed), Shonita (ovum) and Panchikarana (elemental composition of the body), are good examples of such concepts (Kumar, 2017; Valiathan, 2023). The Vedic Gurukul tradition, which followed the Guru-Shishya Parampara system, was focused on gaining knowledge in an integrated way and not in a fragmented manner, like contemporary constructivist approaches advocated by Dewey (1938), Piaget (1970) and Vygotsky (1978). NEP 2020 now mandates the inclusion of Indian Knowledge Systems (IKS), including Vedic and Ayurvedic knowledge, in school syllabi wherever applicable, giving a policy impetus to such classroom-based empirical studies as the present one. The NCERT, Class-8 chapter 'Reproduction in Animals' deals with complex, often delicate concepts of sexual and asexual reproduction, fertilisation, embryonic development and metamorphosis, many of which prove incredibly challenging for students to grasp in the abstract, decontextualised manner in which they are presented in the lesson plan. Incorporating this content within the rich cultural and philosophical vocabulary of Vedic thought could potentially offer greater accessibility, meaning and memorability, while simultaneously instilling a sense of pride in their country's intellectual tradition. With this perspective, the present study attempts to address the problem, "Can integrating Vedic educational principles into biology instruction improve the academic achievement of secondary school students?" The two objectives of the study were to (1) examine the effect of Vedic-integrated biology instruction on students' academic achievement and (2) compare students' pretest and post-test scores following the intervention. The null hypothesis (H₀) was that there would be no significant improvement in biology test scores amongst students taught with Vedic-integrated instruction.

2. Review of Related Literature

The Vedic educational tradition embodied in the Gurukul system integrated cognitive, ethical, physical and spiritual development through practices such as oral transmission (shruti), experiential participation (nididhyasana), contemplative practice and dialogic inquiry (manana) (Pandey et al., 2024, as cited in IJFMR).

Gurukul-inspired instruction has shown superior retention and creative expression compared to mainstream schooling (Iyer & Ramesh, 2025), and its focus on observation and hands-on engagement with organisms aligns with inquiry-based science pedagogy (Bybee, 1997).

Ayurvedic biological frameworks described in classical texts such as the Charaka Samhita and Sushruta Samhita provide detailed and observation-based accounts of gamete formation, fertilisation and embryonic development that find parallels in modern embryology (Valiathan, 2023). Kumar (2017) notes that the concept of Bija predates Mendelian inheritance in emphasising equal hereditary contribution from both parents, while the Ayurvedic staging of embryogenesis (Kalala, Budbuda, Peshi/Ghana, Ankura) finds a parallel in the modern understanding of zygote-morula-blastocyst-gastrula development. Patwardhan et al. (2009) and Acharya et al. (2024) further demonstrate connections between the Tridosha framework and contemporary reproductive and developmental physiology, presenting a coherent conceptual bridge - in Ausubel's (1968) terminology, an advance organiser - between familiar cultural knowledge and unfamiliar scientific content.

NEP 2020 mandates the scientifically informed integration of IKS across curricular levels, with over 8,000 higher-education institutions already adopting IKS content and a dedicated NCERT Curriculum Area Group (Dutta, 2025). Rao and Dwivedi (2023) propose a three-level integration framework encompassing conceptual, methodological and epistemological dimensions, while Nayak and Padhi (2024) show that Vedic pedagogy addresses all aspects of Bloom's taxonomy, including the affective domain. Constructivist and experiential pedagogies provide the methodological basis for the present intervention. The 5E Instructional Model (Engage, Explore, Explain, Elaborate, Evaluate; Bybee et al., 2006), having been validated in 57 studies as producing significant positive effects on science achievement, conceptual understanding and motivation (Polanin et al., 2024), finds structural parallels in Vedic constructs: Engage with Jijnasa (curiosity), Explore with Nididhyasana, Explain with Adhyayana, Elaborate through analogy and debate, and Evaluate through reflective oral assessment.

Empirical evidence supports this approach: Mishra (2014) found traditional Sanskrit school students to have advantages in memory and metacognition, Rangan et al. (2009) reported superior sustained attention among students in yogic education streams, and Ryan and Deci's (2000) Self-Determination Theory posits that intrinsic motivation is maximised when learning experiences are perceived as culturally relevant - a condition likely satisfied for Odia students engaging with Vedic biological content.

3. Methodology

3.1 Research Design: The study employed a quasi-experimental single-group pretest-post-test design with a quantitative research methodology, selected due to the school's logistics as random assignment within an intact school section was infeasible.

3.2 Setting and Sample

The study was conducted in Venkateswar English Medium School, Bhubaneswar, Odisha, a CBSE-affiliated co-educational institution. The population included 30 ($n=30$) students in class VIII (ages 12-14 years) from an intact section selected through random sampling without any restrictions based on prior achievement.

3.3 Tool

A researcher-developed Biology Achievement Test (BAT) worth 50 marks, aligned with the NCERT Class VIII 'Reproduction in Animals' chapter and the learning-outcome framework, was administered to the participants. The test contained six sections: multiple choice questions, fill in the blanks, one-word answers, matching type, true/false, and application type items. It was designed to measure low-and high-level skills (lower- and higher-order thinking skills) as specified by Bloom's revised taxonomy. Experts in teaching class VIII biology designed the test items, and a pilot study was conducted with an identical section to establish content validity.

3.4 Instructional Intervention

The intervention consisted of a 2-week, 6-session (40 min/session) program based on the 5E model that incorporated selected Vedic and Ayurvedic concepts, such as Sravana (listening), Manana (thinking), Nidhidhyasana (contemplation/meditation), Pratyakshya (observation), Yukti (logic), Shastrath (debating), and Abhyas (practice) were integrated into the standard NCERT teaching-learning processes.

3.5 Procedure and Data Analysis

After obtaining the school administration's approval and experts' consent, the BAT was administered to the participants in a controlled environment. The intervention was performed, and the post-test was conducted to measure the skill achievement. The scores were entered into IBM SPSS Statistics. Shapiro-Wilk and Kolmogorov-Smirnov (Lilliefors) tests were performed to check for the data's normality, followed by descriptive statistics, Pearson correlation, and two-tailed paired sample t-test ($\alpha=.05$) (Cohen's d, 1988). The study's scores were collected and stored anonymously, and no individual scores were shared with the school authorities. Participants received no compensation for their involvement, and the scores were not used for any academic or administrative purposes.

4. Results

4.1 Assumption of Normality

Both pretest and post-test score distributions satisfied the assumption of normality required for the parametric paired-samples t-test (Table 1); skewness and kurtosis z-ratios also fell well within the acceptable range of ± 1.96 .

Table 1. Tests of Normality for Pretest and Post-test Scores

Test	Variable	Statistic	df	p
Shapiro-Wilk	Pretest	0.947	30	.142
Shapiro-Wilk	Post-test	0.953	30	.204
K-S (Lilliefors)	Pretest	Z = 0.831	30	.494
K-S (Lilliefors)	Post-test	Z = 0.577	30	.894

4.2 Descriptive Statistics

The mean score increased by 9.30 points from pretest to post-test, an improvement of approximately 39.9%, while the standard deviation and variance decreased, indicating that scores became more homogeneous after the intervention (Table 2). The 95% confidence intervals for pretest [19.20, 27.46] and post-test [29.27, 35.99] means did not overlap.

Table 2. Descriptive Statistics for Pretest and Post-test Scores (N = 30)

Statistic	Score (Pretest)	Score (Post-test)
Mean	23.33	32.63
Median	20.00	33.00
Std. Deviation	11.062	8.992
Variance	122.368	80.861
Skewness (SE)	.347 (.427)	-.061 (.427)
Kurtosis (SE)	-.974 (.833)	-1.041 (.833)

4.3 Paired Samples Correlation

A strong, statistically significant positive correlation was observed between pretest and post-test scores (Table 3), confirming rank-order consistency and the appropriateness of the paired design.

Table 3. Paired Samples Statistics and Correlation

Pair	Mean	N	Std. Deviation	Correlation (Sig.)
Score (Pretest)	23.33	30	11.062	r = .878 (p < .001)
Score (Post-test)	32.63	30	8.992	

4.4 Paired-Samples t-Test

A two-tailed paired-samples t-test revealed a statistically significant improvement in scores following the intervention (Table 4). The null hypothesis was rejected, and the alternative hypothesis that Vedic-integrated instruction significantly improves biology achievement was accepted.

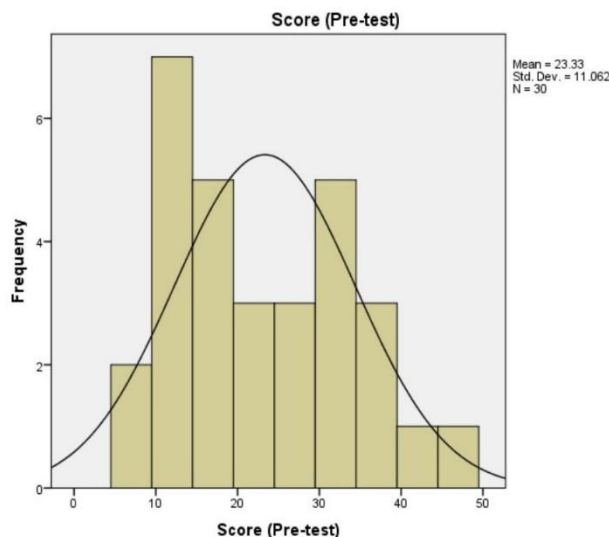
Table 4. Paired Samples t-Test Results (Pretest vs. Post-test, N = 30)

Parameter	Value
Mean Difference (Pre – Post)	-9.300
Std. Deviation of Difference	5.351
Std. Error of Mean Difference	0.977
95% CI of Difference	[-11.298, -7.302]
t-statistic	-9.520
Degrees of Freedom (df)	29
Sig. (2-tailed)	p < .001 (.000)
Paired Correlation (r)	.878 (p < .001)
Cohen's d (Effect Size)	1.74 (Very Large)

4.5 Effect Size

Cohen's d was computed as the mean difference divided by the standard deviation of the differences ($9.300 / 5.351 = 1.74$). Following Cohen's (1988) benchmarks (small = 0.2, moderate = 0.5, large ≥ 0.8), this constitutes a very large effect, indicating that the intervention produced not only statistically significant but also educationally substantial gains, robust even within a sample of 30 students.

Figure 1. Frequency distribution (histogram) of pretest and post-test scores



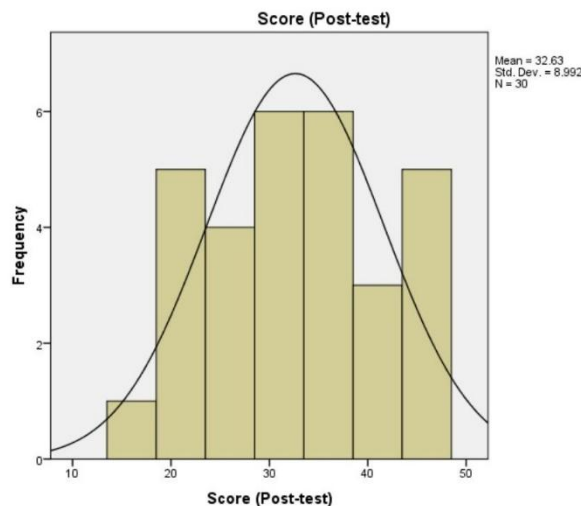


Table 5.

Summary of Major Findings Corresponding to Each Research Objective

Objective	Finding	Statistical Evidence
1. Impact on academic achievement in 'Reproduction in Animals'	Significant improvement in BAT scores following intervention	$t(29) = -9.520, p < .001$; mean gain = 9.30 marks (39.9%)
2. Pretest vs. post-test comparison	Post-test significantly higher than pretest across all ability levels	95% CI [-11.298, -7.302]; CIs non-overlapping

5. Discussion

The statistically significant improvement in achievement scores (mean gain = 9.30 marks; Cohen's $d = 1.74$) is the central finding of this study. The magnitude of this effect, obtained with a modest sample of 30 students, suggests a powerful and consistent instructional impact. This is broadly consistent with the wider literature on constructivist science pedagogy: Polanin et al.'s (2024) 57-study meta-analysis confirms that the 5E model, which formed the structural backbone of the intervention, reliably improves science achievement, and Villanueva and Cruz (2023) report similar pre-to-post gains using a 5E-anchored constructivist biology module. The present findings extend this evidence base by suggesting that enriching the 5E framework with culturally resonant Vedic content may amplify its effectiveness beyond typical 5E-only benchmarks.

The narrowing of score variability from pretest ($SD = 11.06$) to post-test ($SD = 8.99$) is noteworthy: rather than widening the gap between stronger and weaker students, as is common in many interventions, the Vedic-integrated approach appeared to benefit lower-achieving students proportionally more. This pattern is consistent with Ausubel's (1968) advance-organiser theory — students with the least prior biological knowledge may gain the most from culturally familiar conceptual scaffolds such as Garbha, Bija and Srishti, which are already embedded in most Indian students' everyday cultural vocabulary.

These results carry direct relevance for the implementation of NEP 2020, which calls for an education system 'rooted in Indian ethos while aligned with global standards.' The study demonstrates that this mandate can be operationalised in a middle-school biology classroom in a manner that improves measurable academic achievement without diluting NCERT curricular content or objectives, suggesting that IKS integration and academic rigour are complementary rather than competing goals.

6. Conclusion and Educational Implications

Integrating Vedic educational principles into biology instruction produced a statistically significant and practically substantial improvement in the achievement of Class 8 students on the chapter 'Reproduction in Animals' (mean gain = 9.30 marks, 39.9%; $t(29) = -9.520$, $p < .001$; Cohen's $d = 1.74$). The findings suggest that combining modern pedagogical structures (the 5E model) with Vedic constructs of observation, reflection, discussion, reasoning and practice can produce an interactive, learner-centred classroom that enhances both understanding and retention. Contextualising abstract biological concepts through familiar cultural frameworks appears to shift students from passive reception to active knowledge construction, without displacing standard curricular objectives.

For practising biology teachers, the findings indicate that IKS integration is feasible with only a basic familiarity with relevant Vedic and Ayurvedic concepts, and that the 5E model offers a ready-made structure for such integration. For curriculum developers, particularly NCERT's Curriculum Area Group on IKS, the results support enriching existing chapters with supplementary Vedic/Ayurvedic content (e.g., contextual notes, comparative activities) rather than replacing existing material. For teacher education, including B.Ed and Integrated B.Ed–M.Ed programmes, the findings support the inclusion of dedicated units on pedagogical uses of IKS within methods courses. More broadly, the study suggests that IKS integration under NEP 2020 need not be treated merely as policy compliance, but can be a genuine pedagogical resource for building science classrooms that are simultaneously rigorous and culturally rooted.

The study is limited by its single-group quasi-experimental design (which cannot rule out maturation, testing or history effects), a small sample restricted to one school and one chapter, and a short two-week intervention window without follow-up. Future research should employ true experimental designs with control groups, assess retention over one month to one academic year, and extend Vedic-integrated instruction to other biology topics (e.g., cell structure, microorganisms, heredity and evolution, conservation) to test the generalisability of the present effect beyond the topic of reproduction.

References

1. Dutta, A. (2025). Integrating Indian Knowledge Systems in science and education under NEP 2020. Ashim Dutta's Blog.

2. Iyer, R., & Ramesh, P. (2025). Experiential learning and knowledge retention in alternative schools: A comparative study. JETIR.
3. Acharya, L., Suman, S. K., Kanyal, K., Priyadarshani, P., & Pandey, V. S. (2024). The Tridosha concept: A comprehensive study from the perspective of modern science. *Journal of Ayurveda and Holistic Medicine*, XII(III).
4. IJFMR. (2024). The Gurukul system: Ancient pedagogical practices and modern relevance. *International Journal for Multidisciplinary Research*.
5. Kaur, H. (2024). Relevance of Vedic education in the context of the National Education Policy 2020. *Eduphoria*.
6. Nayak, S., & Padhi, S. K. (2024). Curriculum and pedagogy in Indian Knowledge System. *International Journal for Multidisciplinary Research*.
7. Polanin, J. R., Austin, M., Taylor, J. A., Steingut, R. R., Rodgers, M. A., & Williams, R. (2024). Effects of the 5E instructional model: A systematic review and meta-analysis. *AERA Open*.
8. National Council of Educational Research and Training. (2023). *National Curriculum Framework for School Education*. Ministry of Education, Government of India.
9. Rao, S. K., & Dwivedi, A. (2023). Strategies for integrating Indian Knowledge Systems in school curriculum: Opportunities and challenges. *Journal of Indian Education*, 49(1), 33–48.
10. Valiathan, M. S. (2023). Ayurvedic biology and road ahead: The first decade. *Journal of Ayurveda and Integrative Medicine*.
11. Villanueva, J. D., & Cruz, M. R. (2023). Effectiveness of constructivist e-learning module in General Biology. *Sapienza: International Journal of Interdisciplinary Studies*.
12. Karimi, M., Afshari, M., & Hassani, F. (2021). The role of experiential learning on students' motivation and classroom engagement. *Frontiers in Psychology*, 12.
13. Campbell, N. A., Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., & Reece, J. B. (2020). *Biology: A global approach* (12th ed.). Pearson.
14. Government of India. (2020). *National Education Policy 2020*. Ministry of Education.
15. Kumar, S. (2017). Concepts of Panchamahabhuta at elemental level. *World Journal of Pharmaceutical and Medical Research*.
16. Mishra, R. C. (2014). Effects of Sanskrit schooling on cognitive and social processes. *Psychology and Developing Societies*, 26(1), 1–28.
17. Patwardhan, B., Warude, D., Pushpangadan, P., & Bhatt, N. (2009). Building bridges between Ayurveda and modern science. *Journal of Ayurveda and Integrative Medicine*.

18. Rangan, R., Nagendra, H. R., & Bhatt, R. R. (2009). Effect of yogic and modern education on attention and memory. *International Journal of Yoga*, 2(2).
19. Bybee, R. W., Taylor, J. A., Gardner, A., Van Scotter, P., Powell, J. C., Westbrook, A., & Landes, N. (2006). The BSCS 5E instructional model: Origins and effectiveness. BSCS.
20. Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, 55(1), 68–78.
21. Bybee, R. W. (1997). *Achieving scientific literacy: From purposes to practices*. Heinemann.
22. Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.
23. Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.
24. Piaget, J. (1970). *Science of education and the psychology of the child*. Orion Press.
25. Ausubel, D. P. (1968). *Educational psychology: A cognitive view*. Holt, Rinehart and Winston.
26. Dewey, J. (1938). *Experience and education*. Kappa Delta Pi.

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