Implementation of IKS-based Learning Models in STEM Education: A Review

Dr. Jitendra Kumar Jain
Dr. A.P.J. Abdul Kalam University, Indore
Corresponding Author Email : drjitendrakumarjain@aku.ac.in

Abstract:
Implementation of IKS-based learning models (IKS) is an extensive collection of ancient wisdom derived from literature such as the Vedas, Upanishads, and Puranas, covering fields including philosophy, mathematics, medicine, and sustainable technology. Despite its many achievements, IKS's value in science and technology is sometimes overlooked in favor of western frameworks in contemporary education. The historical relevance of IKS and its incorporation into modern STEM (Science, Technology, Engineering, and Mathematics) Education are examined with a focus on how it might promote creativity, intellectual variety, and comprehensive problem-solving. Ayurveda, which provides insights into holistic health and tailored care, and Vedic mathematics, which improves computational thinking and problem-solving abilities, are two important contributions of IKS. Eco-friendly design and conventional water conservation are examples of sustainable technology that can provide important views into solving environmental issues. Furthermore, IKS's multidisciplinary potential is demonstrated by its impact on environmental science, engineering, and astronomy. By connecting traditional knowledge with recent scientific discoveries, incorporating IKS into contemporary curricula through multidisciplinary study, experiential learning, and community involvement can improve education. This strategy, which is backed by the National Education Policy (NEP) 2020, develops a generation of students with technological skills and empathy for culture, promoting creative and sustainable approaches to global problems.

Keywords: Implementation of IKS-based learning models, Science, Technology, Sustainability, Engineering, Mathematics, Technology and Medicine and New Education Policy (NEP)

1. Introduction

Implementation of IKS-based learning models (IKS), that finds its origins in medieval texts such as the Vedas, Upanishads, and Puranas, is an extensive collection of developed knowledge over thousands of years. It involves a holistic approach that incorporates the mind, body, and spirit while integrating philosophy, science, mathematics, and medicine. "Everything in the universe is one family" (Vasudhaiva Kutumbakam) encapsulates the fundamental idea of IKS, which is interconnection (Timane & Wandhe, 2024). Despite its in depth knowledge, the contribution of IKS mainly in the field of science and technology are sometimes overlooked in favor of Western paradigms in contemporary education. However, IKS provides insightful information about sustainable methods and comprehensive problem-solving, which are crucial for today's global issues. By incorporating IKS into modern education, learning environments are enhanced and intellectual variety, creativity, and critical thinking are encouraged. (Chaparro et al., 2016).

Additionally, IKS encourages cultural sensitivity and inclusion, preparing people to live in a globalized society. IKS provides a basis for comprehensive learning that is frequently absent from contemporary models by integrating newly created modern science of knowledge with traditional knowledge. (Chaturvedi et al., 2015).

These days, teachers may build a comprehensive learning environment that prepares students to handle new difficulties and fosters creative research by integrating concepts like Ayurveda, Vedic mathematics, and sustainable technology into contemporary curricula.

2. A Historical View of Indian Knowledge Systems

The huge amount of information, beliefs, and customs from the ancient Indian subcontinent are components of the Indian information System, which has its origins in Hindu philosophy. The Vedic texts, which date back to approximately 1500 BCE and have had a significant influence on India's intellectual, spiritual, and cultural milieu, are the origin of IKS (Kapil Kapoor, 2020). The Vedas, which are regarded as the cornerstone of Indian philosophy, were originally transmitted orally before being codified. They addressed a variety of subjects, such as cosmology, rites, ethics, and spirituality (Mark, 2020).

IKS now constitutes a dynamic integration of contemporary technological advances and traditional knowledge, making a substantial contribution to the fields of philosophy, science, technology, medicine, mathematics, and literature (Mandavkar, 2023). The fundamental ideas of IKS hold true even as Indian academics continue to study and reinterpret ancient writings, providing a source of motivation and guidance for people in India and around the world.

IKS integrates empirical research with philosophical and ethical considerations, spanning a numerous fields including astronomy, mathematics, philosophy, and environmental science. Important writings that established the basis for many scientific disciplines currently studied globally include the Charaka Samhita in medicine and the Shulva Sutras in mathematics. This system has shaped Indian society and culture in many different ways, evolving over centuries while maintaining its core principles.

3. Contributions of Indian Knowledge System in STEM Education

Indian knowledge systems have made numerous important contributions to world science, some of which are as follows:

A. Vedic Mathematics and Astronomy: Exploring new dimensions for calculation in Astronomy.

Vedic mathematics, which has its roots in ancient Indian literature, has had a significant effect on the advancement of mathematics worldwide by developing computational methods that make algebra, geometry, and arithmetic simpler. The decimal system and the idea of zero, which were first recorded in India in the fifth century and served as the basis for contemporary numerical systems, were among the most revolutionary contributions (Joseph, 2000). The sixteen Sutras and thirteen sub-Sutras that make up Vedic mathematics provide a methodical approach to mental arithmetic. Chahine (2023). Prominent mathematicians who made notable contributions to areas like algebra and trigonometry include Varahamihira (505–587 CE), Bhaskara II (1114–1185), and Aryabhata (476–550 CE). The foundation for later developments in mathematics was laid by Aryabhata's work on approximating "pi" and trigonometric functions and Bhaskara II's introduction to differential calculus.

The important areas for integration are as follows:

a. **Problem-Solving Skills:** Introduce Incorporate Vedic approaches into STEM courses, including in computer science, cryptography, and algorithm design, to increase problem-solving speed and efficiency, particularly in competitive settings like programming challenges and Math Olympiads.

b. **Innovative Teaching Methods:** Present different techniques for doing mathematical operations in classes at schools, colleges, and universities using Vedic mathematics, offering learners who are having trouble with the subject shortcuts that can help them feel more confident.

c. **Mathematical Research:** The mathematical contributions made by ancient Indians to

number theory and calculus, which enhance our comprehension of the development of mathematics across time. For fresh perspectives, investigate contemporary uses of these data science and computing methods. Institutions can improve students' computational skills and understanding of the historical significance of mathematics by incorporating Vedic mathematics.

Integrating these rich traditions into the fast-paced, usually divided STEM fields of higher education is a challenge for modern education.

B. Ayurvedic Medicine: Connecting Contemporary Biomedical Research with Conventional Health Systems.

The one of the oldest medical systems in the world, Ayurveda, integrates physical, mental, and spiritual well-being to promote holistic health. Personalized medicine, illness prevention, and natural treatment are the main topics of foundational writings such as the Charaka Samhita, Bhela-Saṃhitā, and Sushruta Samhita (Mukherjee & Wahile, 2006; Singh et al., 2022). The Sushruta Samhita is renowned for its sophisticated surgical methods, such as rhinoplasty and cataract surgery, but the Charaka Samhita places more emphasis on internal medicine and balanced living (Meulenbeld, 1999).

By offering a comprehensive view of health, incorporating Ayurvedic concepts into contemporary higher education helps improve healthcare curriculum. Interdisciplinary courses that combine modern medical sciences with Ayurvedic knowledge can help accomplish this integration (Narayana & Durg, 2021). The most significant strategies consist of:

a. **Interdisciplinary Research:** Research on Ayurvedic herbs can be initiated by collaboration between pharmacology, biochemistry, and botany, which could result in novel treatments for long-term illnesses like diabetes, cancer, and cardiovascular disorders.

b. **Courses on Traditional Medicine:** By creating undergraduate and graduate courses on Ayurveda in conjunction with contemporary pharmacology and biotechnology, students can study alternative healing systems and close the gap between holistic practices and Western medicine.

c. **Clinical Trials and Research:** Traditional techniques can be validated and made more acceptable in global healthcare by promoting evidence-based research on Ayurvedic remedies in combination with biomedical sciences.

Universities can encourage the investigation of alternative medicine techniques and advance a more inventive and inclusive healthcare paradigm by integrating Ayurvedic ideas into biomedical education and research.

C. Sustainable Technologies: Observations from Indian Knowledge Systems

Sustainable solutions like rainwater harvesting eco friendly building are available through the old Indian knowledge system. In order to overcome the current shortage of water, rainwater harvesting—a traditional method of managing water resources—remains essential (Kumar, 2024). Advanced water conservation is demonstrated by structures like stepwells and tanks, which highlight India's sustainable engineering (Agarwal & Narain, 1997). Prior to modern environmental science, these ancient methods of water management, construction, and agriculture placed an emphasis on harmony with the natural world. Books like the Vrikshayurveda (The Hindu Science of Plant Life - Ayurveda for trees) described organic farming, biodiversity preservation, and water conservation as examples of sustainable agricultural methods. In order to preserve natural resources, ancient irrigation methods like building tanks and Stepwells showed sophisticated hydrological and water management skills (Rao, 2001).

Energy-efficient construction was encouraged by traditional Indian architecture, which was typified

by the ideas of Vastu Shastra (the science of architecture). Buildings were designed with natural ventilation, passive heating and cooling systems, and an attention on environmental harmony, and materials were usually acquired locally (Jain, 2016).

By incorporating these sustainable technologies into the classroom, educators can foster environmental responsibility and provide students the skills and information they need to lead innovation within the sustainability framework. Different strategies can be used to accomplish this integration:

a. **Curriculum Development:** Universities can create curricula that combine contemporary environmental engineering and agriculture with sustainable technology from ancient India.
b. **Research Projects**: Integrating ancient knowledge with contemporary technologies can be the subject of interdisciplinary research projects.
c. **Collaborative Learning Models**: Institutions of higher learning can encourage cooperation amongst students studying agriculture, engineering, environmental science, and architecture.
d. **Engaging students in community-based programs:** Reviving old methods like organic farming can have a big influence both at national and international level.

D. Environmental Science and Sustainability:

By focusing on the connection of humans and nature and promoting sustainable resource management and ecosystem knowledge, traditional knowledge systems make a substantial contribution to environmental research (Berkes, 2012). These systems, which are based on long-term ecological observations, provide information about managing natural resources, biodiversity preservation, and sustainable agriculture. Agroforestry and similar practices preserve biodiversity and soil fertility, offering sustainable substitutes for contemporary agriculture (Cajete, 1999).

Furthermore, Australian Aboriginals' "fire-stick farming" lowers the risk of wildfires and safeguards ecosystems (Bliege Bird et al., 2008).

A multidisciplinary approach to tackling global issues like biodiversity loss and climate change is provided by incorporating Indigenous Knowledge Systems (IKS) into environmental science and sustainability education. This strategy preserves indigenous understanding while promoting sustainable practices by integrating traditional knowledge with cutting-edge scientific innovation (Berkes, 2012). Key strategies include:

a. **Incorporation of Case Studies:** To extend knowledge beyond scientific principles to encompass social and cultural elements, environmental science curricula might incorporate IKS-based case studies on biodiversity preservation, water conservation, and land management.
b. **Research Collaborations:** By bringing students and indigenous communities together, research collaborations enhance the educational process by offering practical examples of sustainability concepts.
c. **STEM Education Integration:** By demonstrating to students how indigenous traditions support environmental sustainability and resilience, IKS can enhance the multidisciplinary nature of STEM education.
d. **Holistic Worldview:** In line with ecological balance and social resilience, the National Education Policy (NEP) 2020 promotes the inclusion of IKS in curricula and sustainable living practices (NEP, 2020, p. 38).
e. **Experiential Learning:** Students acquire a deeper comprehension of ecological principles through field investigations and community partnerships that expose them

to local ecosystems and customs directly (Kumar, 2024).

f. **Critical Thinking and Problem-Solving:** Considering environmental concerns from an indigenous perspective fosters creativity and offers students the abilities required to deal with current sustainability problems.

This method fosters an extensive ecological and cultural perspective, which is essential for contemporary sustainability initiatives.

E. Architecture and Engineering

Vastu Shastra which incorporates the concepts of spatial geometry, airflow, and ecological harmony, is the primary way that Indian Knowledge Systems (IKS) have had a significant impact on engineering and architecture (Gupta & Kumar, 2015). Temples and stepwells, two examples of ancient Indian architecture, are examples of this sustainable and well-rounded strategy. Advanced civil engineering techniques, including as water conservation, drainage, and climatic adaptability, were used in cities like Mohenjo-Daro and Harappa, demonstrating IKS's emphasis on practical, environmentally conscious designs.

Texts like the Arthashastra (a treatise on statecraft, political science, economic policy, and military strategy) and Manasara (a science of arts and crafts), an ancient treatise on Indian architecture and design that offers guidelines for fortifications, bridges, and irrigation systems, demonstrate how IKS combines traditional civil and mechanical knowledge in engineering (V. Singh, 2017).

This expertise is demonstrated by the Indus Valley's advanced hydrological knowledge. In addition, advanced material science and empirical knowledge are highlighted by ancient Indian metallurgy, which is demonstrated by the corrosion-resistant Iron Pillar of Delhi (Balasubramaniam, 2002).

The National Education Policy (NEP) 2020, which places an emphasis on Indian Knowledge Systems (IKS) across disciplines, is supporting the growing trend of integrating IKS into higher education engineering and architectural programs. In order to integrate traditional methods with contemporary engineering, institutions such as IIT Kanpur have set up IKS study centers, encouraging comprehensive approaches to sustainability and contextual design (Kumar, 2024). Important strategies consist of:

a. **Holistic Curriculum:** By incorporating IKS into engineering degrees, students are inspired to approach current problems from a cultural and environmental perspective, such as resource management and sustainability (Kumar, 2024).

b. **Community Involvement:** IKS places a strong emphasis on local participation in design and implementation, which is consistent with sustainable development trends that uphold regional customs and give communities more authority.

c. **Sustainability Focus:** Students are able to grasp how historic methods can enhance contemporary sustainable design by including Vāstu Śāstra, or the science of architecture, into architectural courses in addition to contemporary certifications like LEED (Ghosh, 2020).

d. **Case Studies in Civil Engineering:** Important insights for today's engineering problems can be gained from historical urban planning techniques, such as garbage disposal and water management (Kumar, 2024).

This multidisciplinary techniques guarantee that students acquire creative, culturally aware, and ecologically conscious viewpoints, equipping them to tackle difficulties in the future.

Challenges and Opportunities

Although STEM education is crucial for students in the twenty-first century, putting it into practice presents a number of difficulties for teachers. The challenges and Opportunities that faced are as follows:

a. **Absence of formal Frameworks:** In order to successfully integrate traditional knowledge

with STEM disciplines, formal frameworks and curriculum must be developed.

b. Teacher Training: In order to successfully incorporate IKS into their lessons, teachers must get training in its tenets and procedures.

c. Community Engagement: For the educational process to be authentic and relevant, local communities and traditional knowledge holders must be involved.

d. **Multidisciplinary Research:** To develop successful educational strategies and investigate the potential of IKS in STEM education, more research is required.

e. **Resource Limitations:** Many schools, particularly those in rural or low-income regions, lack the resources, tools, and technology required to deliver high-quality STEM education. This includes having access to labs, software, and resources for real-world simulations and experiments.

f. **Curriculum and Pedagogy**: Some STEM courses could be out of date, not place enough emphasis on real-world applications, or not make the connection between STEM ideas and pressing problems. Students' motivation and involvement can be increased by switching to inquiry-, project-, and problem-based learning.

g. **Student Motivation and Engagement:** STEM courses may seem dull, esoteric, or challenging to many students. Using technology and simulations, encouraging curiosity, and tying STEM instruction to real-world applications can all assist increase student motivation and engagement.

4. Conclusion

This study focuses on the Future of STEM through Indian Knowledge Systems. A strategy for innovation, sustainability, and interdisciplinary research, incorporating Indian Knowledge Systems (IKS) into contemporary STEM education in higher education is a regeneration of traditional wisdom. Understanding Vedic mathematics, Ayurvedic medicine, and sustainable technology allows educational institutions to create research projects and curricula that apply traditional wisdom to address modern issues. This method fosters holistic solutions to global problems, expands students' intellectual horizons, and pushes them to think beyond Western scientific norms. It fosters a generation of researchers and students who are technically skilled, morally grounded, culturally conscious, and motivated by innovation, equipping them to take on the challenges of the twenty-first century.

The ability of STEM education to incorporate a variety of knowledge systems, including IKS, is crucial to its future. We can build a more fair, sustainable, and culturally relevant educational system that equips students for the possibilities and challenges of the future by fusing scientific discoveries with traditional knowledge.

There is great potential for the future of STEM education through the incorporation of Indigenous Knowledge Systems (IKS), which provide a comprehensive and culturally appropriate method of instruction and problem-solving. In addition to addressing societal issues, this collaboration may advance sustainability and deepen the understanding of both traditional and scientific knowledge.

5. References

1. Agarwal, A., & Narain, S. (1997). Dying Wisdom: Rise, Fall and Potential of India's Traditional Water Harvesting Systems. Centre for Science and Environment.
2. Bag, A. K. (2018). History of Indian Astronomy: A Review. Indian Journal of History of Science, 53(1), 95–103.
3. Balasubramaniam, R. (2002). On the Corrosion Resistance of the Delhi Iron Pillar. Current Science, 82(12), 1357– 1365.
4. Bora, D., & Das, K. (2021). Vedic mathematics: Simplifying arithmetic for modern engineering students. Mathematics Education Journal, 7(3), 144–159.
5. Chahine, I. C. (2023). IKS and STEM Teaching: A Framework for Integration. SSRN Papers.
6. Chaparro, M., Das, B., & Landaburu, A. (2016). Epistemología de la comunicación en India: Una aproximación histórica más allá del ``desarrollo''. https://core.ac.uk/download/288159360.pdf

7. Chaturvedi, S., Ladikas, M., Stemerding, D., & Zhao, Y. (2015). Science and Technology Governance and Ethics - A Global Perspective from Europe, India and China. https://core.ac.uk/download/42136809.pdf
8. Ghosh, S. (2020). Reviving Traditional Knowledge in Urban Water Management: Lessons from Ancient India. International Journal of Sustainable Architecture, 10(3), 78–86.
9. Gupta, R., & Kumar, P. (2015). Vāstu Śāstra: Integrating Architecture with Nature. Journal of Traditional Knowledge, 14(4), 625–632.
10. Jain, S. (2016). Revival of Vernacular Architecture in India: Understanding the Past for a Sustainable Future. Elsevier.
11. Joseph, G. G. (2000). The Crest of the Peacock: Non-European Roots of Mathematics. Princeton University Press.
12. Kapil Kapoor, A. K. (2020). Indian Knowledge Systems. https://www.lkouniv.ac.in/site/writereaddata/siteContent/202004120632194475nishi_I
13. Kumar, M. J. (2024). Forging Connections: Integrating Indian Knowledge Systems in Higher Education. IETE Technical Review. https://doi.org/10.1080/02564602.2024.2342625
14. Mandavkar, D. P. (2023). Indian Knowledge System (IKS). https://www.researchgate.net/publication/374373778_Indian_K
15. Mark, J. J. (2020). The Vedas. https://www.worldhistory.org/The_Vedas/
16. Meulenbeld, G. J. (1999). A History of Indian Medical Literature. Egbert Forsten.
17. Mukherjee, P. K., & Wahile, A. (2006). Integrated approaches towards drug development are from Ayurveda and other Indian systems of medicine. Journal of Ethnopharmacology, 103(1), 25–35.
18. Narayana, C., & Durg, R. (2021). Ayurveda: A traditional health practice with modern implications. Ayurvedic Studies Review, 8(2), 90–105.
19. Data Protection in the Cloud: A Backup and Recovery Approach by H. NAGA CHANDRIKA1 and DR. PRAMOD PANDURANG JADHAV, Journal of Innovative Engineering and Research (JIER) Vol. - 6, Issue -2, October, 2023, pp. 6-10.
20. Extreme Programming in Software Development Dr. Sanjay Singh Bhadoriya1 and Saurabh Parikh, Journal of Innovative Engineering and Research (JIER) Vol.- 6, Issue -2, October 2023, pp. 16-19
21. A Review on Security of Wireless Sensor Networks using Cryptographic Techniques DINESH KUMAR GUPTA1, DR. DEEPIKA PATHAK2, Journal of Innovative Engineering and Research (JIER) Vol.- 5, Issue -2, October 2022, pp. 17-20 .
22. A Security-focused Review on Virtual Machines MAYANK YADAV, Journal of Innovative Engineering and Research (JIER) Vol.- 5, Issue -1, April 2022, pp. 5- 10.
23. A Performance Comparison of Edge Cover Graph Coloring Approach for Resource Allocation in Cloud Computing Environment NEELEMA RAI, DR. DEEPIKA PATHAK, Journal of Innovative Engineering and Research (JIER) Vol.- 3,Issue - 2,October 2020, pp. 24-29.
24. Design of Chatting Application Based on Android Bluetooth with Hotspot Feature APARNA KHARE1, AKSHAY GUPTA, Journal of Innovative Engineering and Research (JIER) Vol.- 3,Issue - 1, April 2020, pp. 5-6
25. A Novel Technology to Improve Grid Frequency Response on Electrical Power System with High Level of Renewable Generation Penetration VINAY KUMAR, SUNIL BHATT, Journal of Innovative Engineering and Research (JIER) Vol.- 2,Issue - 2, October 2019, pp. 1-4
26. Security Enhancement of Networked Building Automation System in Airports NIKHIL RATHORE, SANTOSH PAWAR, Journal of Innovative Engineering and Research (JIER) Vol.- 2,Issue - 2, October 2019, pp. 16-21.
27. A Study on College Students: Stress Management for Enhanced Academic Performance SHUBHA R. SINGH1* and VIKASH PATIDAR, Journal of Innovative Engineering and Research (JIER) Vol.- 1, Issue - 2, October 2018, pp. 6-10.