

INTEGRATION OF INDIAN KNOWLEDGE SYSTEMS INTO STEM EDUCATION: A MULTIDISCIPLINARY APPROACH TO SUSTAINABLE LEARNING

Sukanya Sil¹ & Dr. Prasanta Gayen² 

¹Research Scholar, Department of Education, School of Education, Adamas University, India; ²Assistant Professor, Department of Education, School of Education, Adamas University, India

Abstract: The Indian knowledge system refers to the long-established body of knowledge developed in our country and transmitted for years, across generations through texts, oral tradition and lived experiences too. The integration of Indian Knowledge Systems into STEM (Science, Technology, and Engineering & Mathematics) education offers a transformative approach to learning by connecting traditional wisdom with modern scientific inquiry. This study examines the relevance of indigenous Indian contributions in Science, Technology, Engineering and Mathematical practices within contemporary STEM curricula. It highlights how combining IKS into this study course can promote interdisciplinary understanding, and which will be followed by critical thinking, ethical awareness, and sustainable problem-solving among students. The amalgamation of activity-based learning and cultural learning with science methods which is prevailed in IKS-based STEM education can help students understand India's rich intellectual traditions. This education also helps students solve comprehensive problems. The study mainly looks at adding knowledge to today's school curricula and that this inclusion does not only make learning more interesting but also encourages synthesis. In short, the focus is on making education more engaging and effective. It aims to prepare students for the challenges of today and tomorrow and IKS-based STEM education is key, to achieving this goal.

Introduction

Education is really important for individuals and societies because it helps people learn things and understand different cultures. In today's world STEM education, which includes Science, Technology, Engineering and Mathematics is a part of how we make new discoveries and grow our economy. Sometimes STEM education focuses too much on technical stuff and not enough on things, like culture, values and traditional wisdom. This is where Indian Knowledge Systems or IKS come in. IKS is a way of combining wisdom with new scientific ideas. It is helping us learn more about science, technology, medicine, math, literature and philosophy. Indian Knowledge Systems is a way to bring traditional knowledge into STEM education. By doing this we can make learning more interesting and meaningful. IKS is contributing a lot to fields, including science, technology, medicine, mathematics, literature and philosophy according to Mandavkar (2023).

Indian Knowledge Systems is a collection of knowledge that people in India have developed over many years. This knowledge has come from people watching things trying things out thinking deeply about things and using things in a way. India has a lot of ideas and discoveries in areas like mathematics, astronomy, medicine and environmental science. Long back, Indian scholars did some really important work that we still use today to think about science. They came up with the idea of zero and the decimal number system, which was a deal. They also made progress in algebra and geometry. Some famous Indian scholars, like Aryabhata and Varahamihira studied the stars and planets. The idea of zero and the decimal system was one of the contributions that India made. This idea started in India around the century and it changed the way we think about numbers. Indian Knowledge Systems is the foundation of numerical systems. There are some books, like the Charaka Samhita, Bhela-Samhitā and Sushruta Samhita that talk about how to make people healthy how to stop people from getting sick and how to use natural things to heal people. These old books show that Indian Knowledge Systems has been thinking about science and new ideas for a long time. Indian Knowledge Systems has been a part of India, for a time.

Modern education often keeps learning separate from the things we see and experience in our daily lives like our local traditions and cultural identity. This creates a gap. We need to change the way we educate people so that we can include knowledge that's relevant to our culture in the things we learn in school. Including Indian Knowledge Systems, in science and math education can help students connect with India's traditions again. It can also make learning more interesting and related to our lives.

The National Education Policy (NEP) 2020 is highly inclined towards combining Indian Knowledge System (IKS) with Science, Technology, Engineering and Mathematics (STEM) education. This will help create a learning environment that is not just about technical skills, but also about culture and overall growth. The policy wants schools and colleges to teach about India's achievements in science, math, arts, medicine, building design, and taking care of the environment. By doing these students will learn about India's heritage that follows development of important skills like creative thinking and critical thinking. The NEP 2020 stressed on the fact that education should make students aware of ethics and help them understand and respect culture. The Indian Knowledge System (IKS) being a part of this will give students a chance to learn from the country's history and traditions. The goal is to create an education system that mixes technical learning with cultural and historical knowledge.

STEM Education is a way to help students understand science and math better. It does this by getting them involved in engineering and technology. This is something that William talked about in 2011. IKS-based STEM education is about learning by doing and using what you learn. In the past people in India learned by watching nature trying things out and working together. If we use these methods in schools today students will find learning fun. Combining Indian knowledge with STEM Education helps students feel good about who they are and where they come from. Students who learn about the science that came from India may feel proud to be Indian. This can help people see that science is not something that happened in Western countries alone and help students understand that knowledge comes from different places and cultures. This way of thinking can help make education fairer by recognizing that there are ways of knowing things. It acknowledges the contributions of different cultures and minds. STEM Education can really benefit from this approach. By learning about STEM Education and its connection, to knowledge students can gain a deeper understanding of the subject. The integration of Indigenous Knowledge Systems into science and math education is really important for the future of our planet and for ideas. A lot of Indian ways of living are all about keeping the earth healthy and using resources in a way that is good for everyone. Things like farming methods, natural medicine and ways of building houses can teach us a lot about how to deal with the big environmental problems we are facing today. For example, collecting rainwater is a way of managing water that is still really important today because many places do not have enough water.

Indigenous Knowledge Systems like growing trees and crops help keep the soil healthy and full of life and this is a better way of farming than some modern methods. By learning about these ways and comparing those to modern science students can come up with new and sustainable solutions to big global problems, like climate change running out of resources and health issues that affect a lot of people. Indigenous Knowledge Systems and science can work together to make the world a better place.

Now, incorporating IKS in STEM education brings about a plethora of interdisciplinary approach however with some conditions. One major challenge is the lack of a structured curriculum frameworks, teaching materials, and trained educators capable of effectively combining traditional and modern knowledge systems. This is needed to be ensured that indigenous knowledge is presented scientifically and critically rather than romantically or uncritically. It should be a must-condition for the Education based institutions to adopt corroboration-based approaches that evaluate traditional knowledge while maintaining academic rigor and scientific standards. In addition, curriculum developers and policymakers need to design inclusive educational models that respect both traditional wisdom and contemporary scientific advancements.

Review of Literature

Kapse et al. (2026) examined the feasibility of integrating Indian Knowledge Systems (IKS) into modern engineering education through the analysis of curriculum, conducting interviews of the faculty members, and student surveys. Their study figured out limited institutional implementation although there had been policy support and proposed a Five-Layer Pedagogical Framework to integrate indigenous knowledge into STEM education, enhancing ethical awareness, cultural relevance, and innovation in engineering learning. Jain and Agrawal (2025) analyzed the role of Indian Knowledge System in modern STEM education. Their study throw light on the contributions of Ayurveda, Vedic mathematics, sustainable technologies, and environmental practices in enhancing creativity, computational thinking, and holistic problem-solving. The authors focused on the integration of IKS through multidisciplinary and experiential learning, supported by National Education Policy (NEP) 2020, to promote culturally rooted, innovative, and sustainable educational practices. Pragati and Kalyani (2026) explored the integration of ancient Indian wisdom with STEM education through a multidisciplinary approach. The study highlighted the role of Indian philosophy, aesthetics, spirituality, and traditional pedagogies in elevating creativity, environmental harmony, and holistic learning. It stressed on integrating oral traditions, Vedic teaching methods, and mathematical practices into contemporary way of study to address contemporary educational and societal challenges. Homavazir and Homavazi (2024) examined the role of India's National Education Policy (NEP) 2020 in fortifying STEM education. The authors highlighted that quality and inclusive education is essential for national growth and global competitiveness. Their study discussed how NEP 2020 replaces the National Education Policy of 1986 that which promoted scientific, technological, engineering, and mathematical learning through systematic implementation, aiming to develop human resources for the benefit of individuals, society, and the nation. Puri (2025) depicted that the Indian Knowledge System (IKS) offers a holistic framework covering disciplines such as philosophy, mathematics, medicine, governance, arts, and architecture. The study emphasized that integrating IKS into undergraduate education can promote critical thinking, ethical values, sustainability, and cultural identity. Focused on the role of the National Education Policy 2020, the paper inspects institutional initiatives and argues that incorporating indigenous knowledge traditions can significantly enrich contemporary higher education and strengthen students' intellectual and national consciousness. Singh (2024) found out that STEM education in Indian higher education institutions is influenced by the National Education Policy 2020 and the growing global demand for STEM professionals. The study highlights improvements in STEM enrollment, curriculum innovation, research, and creative pedagogy. However, challenges such as high costs, academic pressure, social biases, and gaps between school and higher education persist. The author recommends stronger industry collaboration, inclusive practices, better infrastructure, and integrated STEM learning to prepare students for future global opportunities. The study by Chen and Wu (2024) highlights how Indigenous cultures have long practiced sustainability, unlike modern Western society where such values are declining. The authors propose integrating STEM education with Indigenous knowledge, especially in disaster prevention for children. Using NGSS standards, cultural curriculum models, and a five-stage learning cycle, the study develops a sustainability-focused Indigenous teaching framework that blends traditional wisdom with modern educational approaches. Abbasi (2024) examined the integration of the Indian Knowledge System (IKS) into teacher education in line with the National Education Policy (NEP) 2020 and University Grants Commission (UGC) guidelines. The study highlighted that incorporating Indian Knowledge Systems through curriculum reforms, interdisciplinary teaching, cultural values, and teacher training can create inclusive and all-emcompassing learning environments while strengthening cultural awareness and improving the quality of teacher education in India. Ogunniyi and Iwuanyanwu (2024) explored STEM teachers' perspectives on integration of Indian Knowledge Systems (IKS) into multidisciplinary STEM education for sustainability of learning. Their study found that dialogic argumentation workshops helped teachers develop more positive attitudes toward IKS, recognizing its role in promoting sustainability and reflective reasoning. The authors concluded that integrating IKS can strengthen STEM teacher education and support innovative approaches to solving complex environmental and social challenges.

Objectives of the Study

- To explore the concept of integrating Indian Knowledge Systems into STEM Education.

- To analyze the role of IKS in enhancing STEM learning and critical thinking.
- To identify challenges and opportunities in integrating IKS with STEM Education.

Research Questions

- How can Indian Knowledge System be integrated into STEM Education to promote holistic and interdisciplinary learning?
- What role does Indian Knowledge Systems play in enhancing STEM learning outcomes, critical thinking, and problem-solving skills among learners?
- What are the major challenges and opportunities in integrating IKS with contemporary STEM Education?

Methodology: A qualitative method has been chosen for the study, which involves a review of related studies and deep analysis of the same.

Analysis & Interpretation

Integration of IKS into STEM education for the promotion of holistic and interdisciplinary learning: The Indian Knowledge Systems can be a way to teach STEM subjects in a way that is connected to our culture. India has a lot of ideas and discoveries that can help students learn about science, math, technology and the environment in a more meaningful way. STEM subjects can be taught by combining Indian ideas with modern science concepts. This way of teaching can help students learn in a complete and hands-on way. For example, during a mathematics the discussion about how Indian mathematicians like Aryabhata came up with the concept of zero and decimal notation can help students understand the history and culture behind the math they are learning. Similarly, in science class the principles of Ayurveda to learn about plants that can be used for medicine, biodiversity and how to stay healthy. According to Akoijam Pete Meitei & Chingtham Naobema Dev (2021), combining IKS with various subjects such as science, social studies, and art enriches the learning experience. By working on projects that combine science, technology, ethics and traditional Indian practices, students can learn to think, be creative and understand the importance of taking care of the environment. This way of learning can help students appreciate the Indian Knowledge Systems and learn in a complete and interdisciplinary way.

Role of IKS in enhancing STEM learning outcomes, critical thinking and problem-solving skills among learners: Indian Knowledge Systems can really make a difference in how we learn about Science and Technology and Mathematics. Traditional Indian contributions in mathematics, astronomy, medicine, metallurgy, agriculture, and architecture provide learners with historical and practical perspectives that enrich STEM education. For example, the mathematical works of Aryabhata and Brahmagupta help students understand numerical reasoning and algebraic thinking, while Ayurvedic principles encourage systems thinking and interdisciplinary inquiry. The study of classical systems like Vedic Mathematics and ancient texts by scholars such as Pingala, actually the binary numbers and Aryabhata's trigonometry and astronomy trains students in mental agility, pattern recognition, and computational thinking. Again, if this side can be focused- the ancient's Panchadi system focuses on observation, reflection, and experiential learning pedagogy (a five-step integrated learning approach) focuses on observation, reflection, and experiential learning. Rather than accepting rote truths, this challenges students to investigate the 'how' and 'why' behind phenomena, promoting a rational and analytical mindset. In this context, Joseph (2011) found that, the invention of the concept of zero, attributed to Indian mathematician Aryabhata, revolutionized mathematics and is considered one of the greatest innovations in human history.

The major challenges and opportunities in integrating IKS with contemporary STEM education: Integrating Indian Knowledge Systems with the things we inculcate is crucial and there is a huge need for that but implementing the same is not that easy. The main role who is responsible for the integration is the mentors, the teachers. They are needed to be trained enough how to assimilate the old golden practices with the contemporary teaching methods. Much of the academic institutions lack faculty members who are well-versed in IKS, resulting in insufficient

knowledge to teach these subjects effectively or to incorporate them into existing curricula. This expertise gap can lead to a narrow understanding of IKS, which diminishes its perceived value in educational settings (Kumar, 2018). Again, proper infrastructure for STEM is very crucial and for the integrating teaching practice which will be even more to compare or suggest example but it lacks in maximum cases. Institutional resistance is also not a lesser problem. Many educational institutions operate within established frameworks that prioritize Western epistemologies, often viewing IKS as peripheral or less rigorous compared to conventional disciplines (Rudra, 2015). Many educational institutions feel comfort and operate within established frameworks that prioritize West, often viewing IKS as peripheral or less rigorous compared to conventional disciplines (Rudra, 2015). Moreover, IKS is vast, diverse, and intensely localized. The lack of standardized assessment frameworks and structured academic resources makes uniform integration difficult at the state or national level.

Educational Implications

Integrating the Indian Knowledge System into STEM education enriches modern course of study with historical context, removing the colonization in learning thus, helping in retaining the environmental balance. The blend of ancient prudence with modern science, education shifts from rote learning to hands on learning which fosters the long-term cognitive retention and a sustainable outlook. There are several areas where IKS contributes to the STEM field. Some of them are mentioned below:

Holistic & Multidisciplinary Understanding: Holistic and multidisciplinary understanding is very important. Integrating Indigenous Knowledge Systems or IKS helps break down barriers between subjects. For example IKS includes things like Vedic Mathematics, which helps people think better and do math in their heads. It also includes ways of working with metal or farming which combine chemistry, biology and economics in a very useful way.

Experiential and Contextual Learning: Experiential and contextual learning is another part of IKS. This means that of just memorizing things students get to learn by doing. They go out. Observe the world around them and get to interact with their local environment.

Shift in Educator Role: The role of teachers is also changing. Their work are not limited to giving out information anymore. Now they are like guides and coaches. They help students connect ideas and principles with new scientific discoveries and principles. Indigenous Knowledge Systems or IKS is playing a role, in this change. IKS is helping students learn in a hands-on and interactive way.

Enhanced Knowledge Retention: When we teach things in a way that makes sense to people in their own community they remember the science and technical areas better. This is because it is connected to their life. Studies show that when we use real life examples from the community people are able to recall the principles for a long time. This is what happens when we ground concepts in the local culture and use information, from real community surveys to teach science.

Conclusion

Integrating Indian Knowledge Systems (IKS) into STEM education offers a transformative approach to teaching and learning by connecting India's rich intellectual heritage with contemporary scientific knowledge. Such integration promotes holistic, interdisciplinary, and culturally relevant education, enabling learners to understand scientific concepts through indigenous perspectives and real-world contexts. Traditional contributions in mathematics and astronomy and medicine and agriculture and architecture and sustainability are really helpful for making STEM classes more interesting and for helping people think critically and be creative and come up with new ideas. In alignment with the goals of the National Education Policy (NEP) 2020, the integration of IKS into STEM education can contribute to the development of scientifically skilled, socially responsible, and culturally grounded citizens.

Thus, IKS serves as a valuable foundation for fostering innovation, sustainability, and lifelong learning in the twenty-first century.

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