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Research Paper

Towards Anxiety Free Mathematics Classrooms in Northeast India: A Conceptual Framework for Integrating Indian Knowledge into Mathematics Pedagogy

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ABSTRACT

The Indian Knowledge System (IKS) in mathematics is one of the oldest and most profound intellectual traditions which provides a holistic and culturally rooted approach to address these challenges by incorporating historical evolution, philosophical foundations, and practical applications integrated in daily life. Mathematics anxiety is a significant psychological barrier that negatively influences student's participation, achievement and problem-solving abilities in mathematics, often leading to low academic achievement, reduced self-efficacy, and avoidance of mathematical tasks. In Northeast India's rich culturally and linguistically diverse region, especially in states like Arunachal Pradesh, Nagaland, Mizoram, and Manipur where standardized mathematics teaching often remains detached from the learners' socio-cultural backgrounds, which further intensifies anxiety and restricts meaningful learning. This conceptual paper explores how IKS, including regional tribal practices and broader Indian traditions, can serve as effective teaching aids to create inclusive, emotionally supportive mathematics classrooms. Drawing on existing literature from mathematics education, ethnomathematics, and culturally responsive pedagogy, the paper argues that integrating IKS integrated pedagogy can significantly enhanced conceptual understanding, academic achievement, and confidence of learners while highlighting practical implications for educators, curriculum developers, and policymakers aiming to promote culturally relevant and anxiety free mathematics learning environment in Northeast India.

Keywords: *Mathematics anxiety, Indigenous Knowledge Systems (IKS), Ethnomathematics, Culturally responsive pedagogy, Mathematics education, NEP 2020, Northeast India*

Mathematics is widely recognised as a fundamental discipline for fostering logical reasoning, critical thinking and problem-solving abilities of learners. Despite of its significance several students perceive mathematics as complex and intimidating discipline giving birth to anxiety. It is defined as a sense of fear, stress or discomfort that makes an individual inability to perform mathematics related tasks. Overtime mathematics

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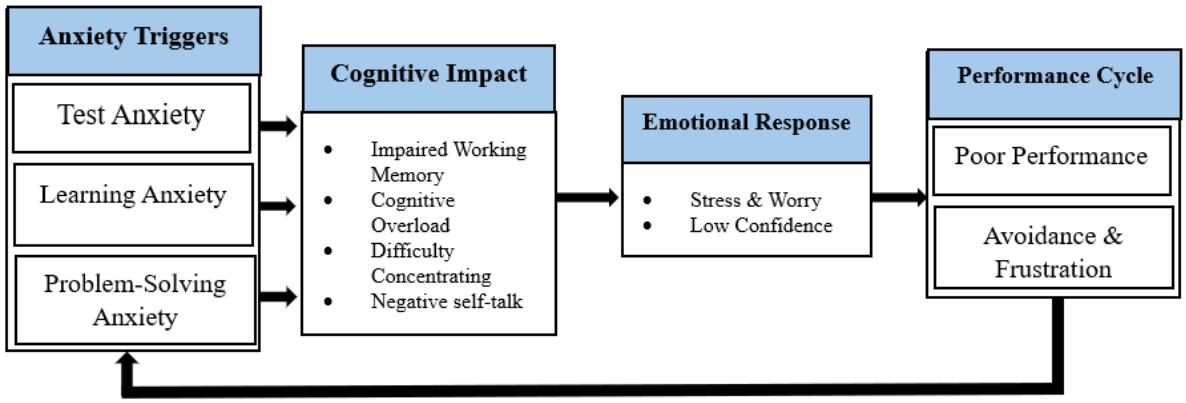
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anxiety has been identified as a major psychological barrier that impacts students' participation and academic performance (Ashcraft, 2002). It interferes mental processes by interfering with working memory, causing emotional distress, and avoidance behaviours which often leads to low academic achievement and reduced self-confidence (Krause, 2007; Carey et al., 2016; Namkung et al., 2019). Secondary stage learners consistently experience moderate level of mathematics anxiety, negatively affecting academic performance (Acharya et al., 2026), which intensified especially in Northeast India, where there is vast linguistic and cultural diversity. Standardized curricula often fail to reflect socio-cultural contexts, causing mathematics perceived to be abstract and irrelevant from real life, therefore increasing learners' disengagement and anxiety towards mathematics (Sharma & Singh, 2025).

Recent reforms in education systems, that is introduction of NEP 2020, which emphasize the need for inclusive, experiential, and culturally rooted learning. Indigenous Knowledge System (IKS), encompassing ancient Indian wisdoms such as zero, decimal system, algebra, geometry from the Sulba Sutras, works of Aryabhata, Brahmagupta, and Bhaskara II and sound practices of tribal communities from Northeast offers a valuable integrative approach. These knowledge system fosters holistic, contextual, and hands on learning, linking mathematical concepts with daily community activities (Upadhyay & Pandey, 2025; Guite & Verma, 2025; Plofker, 2009; Joseph, 2011). Thus, the integration of IKS not only compliments the vision of NEP 2020 but also offers a culturally grounded approach to make mathematics learning more meaningful, inclusive and approachable for learners (Arora, 2025).

Figure 1 Mathematics Anxiety and Its Effects on Students' Cognitive Processes, Performance, and Emotional Responses



Note: Illustration based on Ashcraft & Krause (2007), Carey et al., (2016) and Namkung et al., (2019)

Background and Significance of the Study

Globally, Mathematics anxiety is considered as a critical obstacle to effective learning. According to Archarya et al., (2026), a substantial number of students experiences moderate to high levels of anxiety adversely affecting their academic performance, self-efficacy and motivation. Large scale assessments show significant gaps in students' competencies in mathematics which is concerning especially in the Indian educational context. Existing literature shows that combination of cognitive factors which includes low self-confidence and negative perception about mathematical ability, instructional variables include

ineffective teaching approaches such as rote learning and excessive emphasis on formal assessment and socio-cultural variables such as classroom pressure, parents' expectations and societal attitude influences students' anxiety towards mathematics (Tanjung et al., 2024; Sharma & Singh, 2025).

The issue is further complicated due to the lack of harmony between formal education and Indigenous cultural practices particularly in Northeast India. As Indigenous communities hold rich knowledge systems which is embedded in their daily activities such as weaving, agriculture, architecture, & trade which inherently involves mathematics concepts such as patterns, measurement, estimation & symmetry. This wisdom is rarely integrated into formal education system (Kumar & Gopinath, 2025; Pradhan et al., 2021).

The paper seeks to address this gap by integrating IKS into mathematics pedagogy which align with the vision of NEP 2020 and has potential to reduce mathematics anxiety by making learning more meaningful, relatable and engaging.

Figure 2 Examples of Indigenous Knowledge Systems in Northeast India showing embedded Mathematical Concepts such as Symmetry (weaving), Measurement (agriculture), and Geometry (bamboo architecture)



Note: Author's compilation adapted from the Ubiratan D'Ambrosio (1985), Alan J. Bishop (1988), Choudhury (2004), Chaudhuri (2014), Joli (2019), and Moudgil (2014).

Objectives of the Study

1. To explore how Indian Knowledge System (IKS) can reduce mathematics anxiety among secondary learners.
2. To develop a conceptual framework for integrating Indian Knowledge System (IKS) into mathematics pedagogy in Northeast India.

LITERATURE REVIEW

Mathematics anxiety is a complex psychological construct comprising multiple dimensions such as anxiety related to evaluation anxiety which is fear associated with examinations, learning anxiety arises from difficulties in comprehending mathematical concepts and problem-solving anxiety is linked to inability to apply knowledge effectively (Archarya et

al., 2026; Tanjung et al., 2024). Mathematics anxiety interferes with mental processes, particularly working memory which reduces students' ability to perform mathematical related tasks effectively (Ashcraft & Krause, 2007). This interference leads to a cycle of low performance and high anxiety (Carey et al., 2016).

A comprehensive review of related literature identifies several major variables of mathematics anxiety such as negative learning experiences, cognitive limitations, instructional practices and socio-cultural influences (Tanjung et al., 2024). High anxiety often influenced by instructional practices that emphasize speed, accuracy, and rote memorization and hinder conceptual understanding (Sharma & Singh, 2025).

Environment variables such as classroom environment, societal stereotypes and expectation of parents play a pivotal role in moulding students' attitude towards mathematics. These elements contribute to the evolution and persistence of mathematics anxiety across different stages of education.

Indian Knowledge System (IKS) constitute a rich repository of mathematical knowledge evolved over centuries. The concepts of Zero (Sunya), decimal system, algebra, geometry, and trigonometry are the significant contributions made by ancient Indian mathematics (Bhinde, 2025). The ancient text such as Sulba Sutra, for example shows advanced geometric principles used in the construction and measurement (Rosangliana, 2025). In Northeast India, IKS within tribal communities further enriches this tradition by integrating diverse ethnomathematical practices, including fractal like patterns and geometric symmetries in Mizo and Naga weaving (reflecting transformations such as reflection, rotation, and translation), spatial measurement and proportional reasoning in bamboo housing and bridges, estimation and optimization of jhum cultivation and Apatani paddy fish systems as well as pattern recognition embedded in oral traditions, folklore, and craft (Guite & Verma, 2025; ethnomathematics studies on weaving and bamboo). According to Upadhyay and Pandey (2025), these approaches to learning are experience based, contextual and holistic that connects mathematics to practical activities in order to make mathematics learning more meaningful and accessible to learners (Bardhan et al., 2025; Pradhan et al., 2021).

The integration of cultural background of the learners into teaching learning process is emphasized through culturally responsive pedagogy (Gay, 2018). Similarly, mathematics knowledge is deeply rooted within cultural contexts and different across communities (D'Ambrosio, 1985). The integration of IKS into mathematics pedagogy can increase engagement, improve learning outcomes and reduce anxiety levels by making mathematics learning more meaningful and relevant (Guite and Verma, 2025; Kumar & Gopinath, 2025; Rosa & Orey, 2016; Pradhan et al., 2021).

METHODOLOGY

This paper is based on a qualitative review of existing literatures. Sources include peer-reviewed studies on mathematics anxiety, Indigenous knowledge System (IKS), and ethnomathematics. The paper also includes the recommendations of NEP 2020 and socio-cultural studies focusing on Northeast India. The literature reviews were examined to understand how mathematics anxiety develops, how mathematics ideas are reflected in IKS and how these ideas can be meaningfully integrated with mathematics education rather than

simply summarising the existing literature, the paper critically examines these variables and their relevance to mathematics.

Result of the study

Conceptual framework for incorporating IKS into mathematics pedagogy offers a practical way for integrating IKS into mathematics pedagogy in Northeast India. It addresses mathematics anxiety by shifting it beyond abstract and decontextualized instruction and connecting mathematical insights with learner's cultural experience and emotionally supportive learning environment. The framework rests on five components each tailored with the region's rich diverse approaches, such as weaving, bamboo construction and agriculture while also recognising the broader tradition of IKS including mathematical ideas found in scriptures like Sulba Sutra (Arora, 2025; Pradhan et al., 2021).

1. **Culturally Relevant Learning:** Mathematical concepts can be connected with learner's cultural experience and traditional knowledge. For example, reflection, rotation, translation and symmetry can be shown using Mizo and Naga weaving patterns, which include Puan and Shawls that have different designs and motifs, including stars, flowers and tiger stripes. Traditional practices such as Apatani rice cultivation and the use of bamboo in constructing houses and bridges in Northeast India, concepts such as measurement, ratio, estimation and proportion can be explained. Connecting mathematics with traditional practices can make learning more meaningful. It also gives emphasis to their cultural background and help them to understand that mathematics is part of their daily life (Guite & Verma, 2025; Pradhan et al., 2021; Gay, 2018).
2. **Experiential Learning:** Learning by doing approach is emphasized where students actively participate with physical material and everyday activities instead of working only with abstract ideas. For example, rope-based geometry, as described in the Sulba Sutra uses rope to make angles, circles and squares for building altars. Similar ideas can also be integrated with local practices, such as making mandala like patterns using bamboo sticks or build models of traditional bamboo houses. These activities help students to learn about size, shape and balance in a more practical way. By learning through practical activities, learners use physical experience to understand concepts and make it easier to manage the working memory demands that can contribute to mathematics anxiety (Arora. 2025; Tanjung et al., 2024; Lakoff & Nunez, 2000).
3. **Collaborative and Community Based Learning:** In this approach, learning through group discussions, storytelling and participation in community activities. For example, mathematical concepts can be learned through folk stories and oral traditions such as pattern and counting system found in Naga traditions. Leaners can also take part in community-based activities such as creating weaving patterns that use symmetry or planning agricultural fields using estimation and optimisation. These activities provide learners an opportunity to support, communicate and share ideas, reducing the fear of failing or making mistakes, creating a more positive and supporting environment that help reducing mathematics anxiety (Tanjung et al., 2024; Pradhan et al., 2021).
4. **Emotional Support:** The classroom environment should be comfortable and supportive, where learners do not feel too much pressure while learning mathematics, reflecting the holistic and fear free ethos of traditional education. Teachers can focus on understanding concepts, reflection and student's efforts

instead of emphasising too much on speed and rote memorisation. Activity based learning such as mathematics riddles based on folk stories or rhythm-based games from oral traditions makes learning more engaging and enjoyable. Such activities help students deal with fear of being judged and negative perceptions about their mathematical ability by creating a psychologically safe classroom environment and boosting confidence in learning mathematics (Acharya et al., 2026; Tanjung et al., 2024).

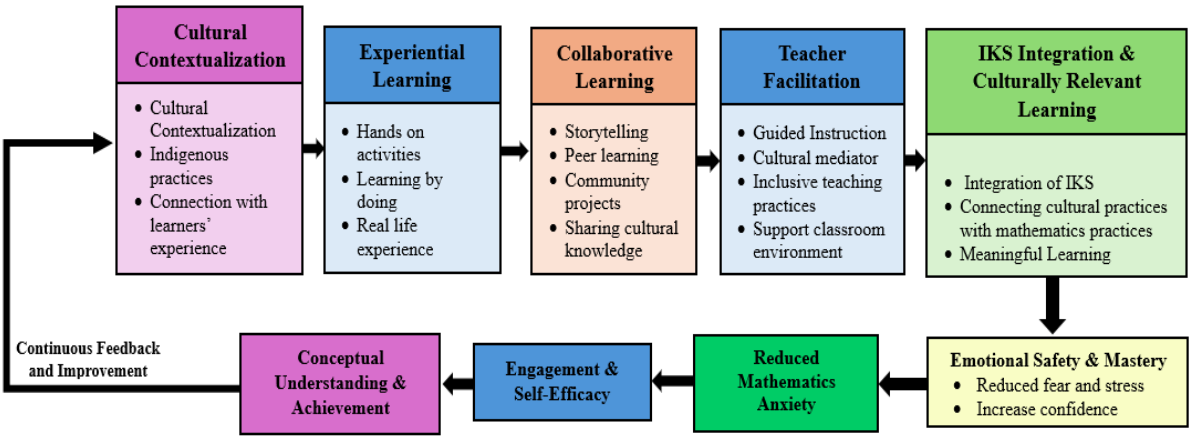
5. **Teacher Facilitation:** Instead of being the only source of knowledge, teachers act as cultural mediators. To identify elements of IKS in local practices and connect them with classroom instruction, proper training is required, which may include training on ethnomathematics, local examples form Northeast India such as weaving, agriculture and bamboo craftsmanship, as well as ways to bridge IKS with the formal curriculum. Such training can help make the teaching learning process more inclusive (Turmuzi et al., 2024; Sunzuma & Maharaj, 2019)

The five components collectively function through a dynamic process model that shows how IKS integration reduces mathematics anxiety and improve learning outcomes.

Process Model

The framework functions as a dynamic and cyclic process. It begins with the integration of IKS through five key components: contextualized cultural examples, embodied learning tasks, emotional support, collaborative narratives and teacher facilitation. This integration promotes meaningful and culturally relevant learning by reducing abstraction, lowering mental load, and validating learners' cultural identities. By minimizing working memory interference, fear of evaluation, and negative perceptions related to mathematics, the framework significantly reduces mathematics anxiety. Through active participation, persistence and confidence in learning mathematical tasks, learners exhibit greater confidence and engagement, leads to a better understanding of mathematical concepts, improve problem solving abilities and academic achievement (Arora, 2025; Guite & Verma, 2025; Tanjung et al., 2024).

Figure 3 Conceptual Framework for Integrating IKS into Mathematics Pedagogy to Reduce Anxiety in the Classroom of Northeast India



Note: Authors' conceptual framework developed from on review of literatures on ethnomathematics, culturally responsive pedagogy, and mathematics anxiety.

DISCUSSION AND IMPLICATION

Mathematics instructions through traditional approach does not always address the different factors that influences mathematics anxiety. This makes learners less interest in learning mathematics and less willing to participate in mathematical tasks. By integrating IKS into mainstream education provides a meaningful way of teaching mathematics by connecting it with practical activities and cultural experiences of learners. For example, students can learn reasoning by observing bamboo architecture and construction practices, while geometric transformations can be taught using traditional weaving patterns from Northeast India. Such connections can make mathematical ideas comprehensible, boost confidence and reduce the mental stress of learning abstract concepts (Guite & Verma 2025; Tanjung et al. 2024; Pradhan et al., 2021).

Based on these findings, several implications can be identified:
For Educators: As suggested by NEP 2020, educators need continuous professional development on culturally responsive teaching and ethnomathematics. It can include hands on activities, such as identifying in symmetry in traditional '*Mizo Puan'* designs or building geometric models using *bamboo*. Teachers working in remote areas can share IKS based teaching resources and ideas using digital platforms and MOOCs (Turmuzi et al., 2024; Sunzuma & Maharaj, 2019).

For Curriculum Developers and Policymakers: The wisdom of IKS from Northeast India must be included into mathematics. For example, *weaving patterns* to teach symmetry and transformations in geometry lessons and agricultural practices such as *paddy cultivation* and *terrace farming* can be included, which can be used to explain measurement and estimation. Examples related to local traditions and integrating them with the vision of NEP 2020 and NCFSE 2023 can make curriculum more relevant and makes mathematics learning more meaningful for learners (Howlader & Sarkar, 2025).

Policymakers play a significant role in expanding the integration of IKS, which can include creating local IKS resource banks, providing support & funding for pilot projects in school locality in Northeast India and also encourage collaboration among teachers, local artisans and researchers. Assessment and evaluation method should be flexible and it should move away from rote memorisation to conceptual or competency-based learning. For example, students can be evaluated through projects including mathematical models based on local culture practices or solving practical community problems using mathematical concepts (Turmuzi et al., 2024).

Future Research Suggestions: To examine the effectiveness of the proposed framework more empirical research is required. Research validated scales can be used to see whether mathematics anxiety among learner's changes after the intervention (Acharya et al., 2026). Longitudinal researches can also be conducted to understand how IKS integrated pedagogy influences academic achievement, attitude towards mathematics and identity formation among learners (Turmuzi et al., 2024; Kumar & Gopinath, 2025).

CONCLUSION

In Northeast India, mathematics anxiety continues to be concern for effective learning (Acharya et al., 2026). Mathematics anxiety increases as conventional teaching approaches give less emphasis on cultural backgrounds and experiences of learners (Sharma & Singh, 2025; Pradhan et al., 2021). This paper suggests that integrating IKS, including mathematics

knowledge and tribal ways of life in Northeast India such as weaving, farming and bamboo architecture can give a meaningful way of mathematics learning which can decrease mathematics anxiety as it connects mathematics concepts with familiar local cultural practices and experiences of learners (Guite & Verma, 2025; Pradhan et al., 2021; Kumar & Gopinath, 2025). This approach can boost learner's confidence and conceptual understanding improving their academic achievement (Guite & Verma, 2025; Arora, 2025).

IKS integrated mathematics teaching can also help learners to acknowledge the significant relationship between their cultural background and mathematics (Gay, 2018; D'Ambrosio, 1985; Pradhan et al., 2021). This helps learners to view mathematics not only as an abstract discipline but also to understand that mathematics influences the practices and knowledge of their communities (Pradhan et al., 2021; Kumar & Gopinath, 2025). Proper training, flexibility in the curriculum and community involvement are required to put this approach into practice (Sunzuma & Maharaj, 2019, Turmuzi et al., 2024; Turmuzi et al., 2024). To meet the contemporary educational needs aligned with the vision of NEP 2020, these areas are important for developing an education system that respect IKS (Arora, 2025; Kumar & Gopinath, 2025). Lastly, Integration of IKS into mathematics instruction has the potential to support not only mathematical learning but also confidence, pride in their indigenous culture and a positive attitude towards mathematics among learners in Northeast India (Gay, 2018; Kumar & Gopinath, 2025; Guite & Verma, 2025).

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Conflict of Interest

The author(s) declared no conflict of interest.

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