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TEACHING MATHEMATICS THE BHĀSKARĀCHĀRYA WAY

LESSONS IN LEARNING FROM INDIA'S GREATEST MATHEMATICS TEACHER

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Abstract

This paper examines Bhāskarāchārya's unique pedagogical methods, which are characterised by emotional intelligence, poetic storytelling, spiritual integration, and intuitive problem-solving strategies. The research analyses examples from his seminal works, especially *Līlāvātī*, to illustrate how Bhāskarāchārya engaged students emotionally, intellectually, and spiritually. His methods contrast sharply with conventional contemporary practices, offering valuable insights for modern education. Through comparative analysis with contemporary educational theories, the paper highlights practical implications for enhancing mathematics teaching today, making it more intuitive, engaging, and culturally meaningful for learners.

Keywords

Bhāskarāchārya, Teaching Methodology, Indian Mathematics, Pedagogy, *Līlāvātī*, Intuitive Learning, Indian Knowledge System

Introduction

Bhāskarāchārya is regarded as one of the most outstanding mathematics teachers in history, owing to his unique blend of mathematical brilliance and pedagogical innovation. India has produced remarkable mathematicians from ancient masters like Aryabhata and Brahmagupta to modern legends such as Ramanujan and Manjul Bhargava. There have also been outstanding educators renowned worldwide for their teaching abilities. However, Bhāskarāchārya uniquely embodies a rare combination of exceptional mathematical insight and pedagogical excellence.

The breadth and depth of Bhāskarāchārya's expertise is eloquently captured by the verse:

अष्टौ व्याकरणानि षट्चभिषजां व्याचष्ट ता स्संहिताः ।

षट्कर्कान्नाणितानि पंच चतुरो वेदा नधीतेस्मयः ॥

(³*Līlāvātī Ganitamū, 2016, p. xxiii*)

Bhāskarāchārya mastered eight systems of grammar, six treatises on medicine, six schools of logic, five branches of mathematics, and four Vedas.

Today, mathematics education is often narrowly viewed as a tool for achieving high marks and excelling in competitive exams. Most classrooms predominantly rely on rote memorisation and formula-driven problem-solving, neglecting conceptual understanding and the joy of discovery. Students rarely experience the beauty or practicality inherent in mathematics. This research addresses these gaps by examining Bhāskarāchārya's teaching approach, seeking insights to rejuvenate contemporary mathematics education with meaningful, engaging, and intuitive learning experiences.

Historical Context

Bhāskarāchārya (1114–1185 CE) was one of medieval India's most influential mathematicians and astronomers. Born in the Maharashtra region, he was a leading scholar of the astronomical school of Ujjain, a significant center for mathematical and scientific advancements in ancient India. His most notable works include *Līlāvātī* (arithmetic and geometry), *Bījaganita* (algebra), *Siddhānta Śiromaṇi* (astronomy), and *Karaṇa-kutūhalam* (practical astronomy). These texts advanced mathematical knowledge and served as important educational tools for centuries.

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During Bhāskarāchārya's time, mathematics education in India followed the Gurukula system, where students learned through oral instruction, memorisation, and problem-solving exercises under the guidance of a guru. Mathematical concepts were often taught using poetic verses to enhance understanding and engagement, a technique Bhāskarāchārya refined and perfected in his texts. His work reflects a seamless blend of rigorous mathematical reasoning with intuitive explanations, making complex ideas accessible to learners.

Bhāskarāchārya's works influenced generations of mathematicians in India and beyond. His emphasis on conceptual clarity, multiple approaches to problem-solving, and interactive learning remain relevant even today, offering insights into how mathematics education can be more engaging and effective.

Pedagogical Analysis:

Bhāskarāchārya's teaching philosophy is a testament to his deep understanding of how students learn. His methods were innovative for his time and highly structured, engaging, and intuitive. By combining mathematical rigor with poetic elegance, he ensured that learning was both enjoyable and intellectually stimulating. Unlike rigid instruction that relies solely on memorisation, Bhāskarāchārya's approach fostered curiosity, conceptual clarity, and problem-solving skills.

The following sections examine key aspects of his teaching methodology.

★ Care and Encouragement for Students (Emotional Intelligence in Teaching)

Bhāskarāchārya's approach to teaching mathematics was deeply student-centered and characterised by affection, patience, and encouragement. Unlike many traditional teaching methods that relied on strict discipline, he nurtured an environment where students could learn joyfully and explore concepts with curiosity rather than fear. His affectionate tone is evident throughout *Līlāvātī*, where he addresses the learner with warmth and motivation rather than authoritative instruction. Two such verses reflect his nurturing approach:

नवघनं त्रिघनस्य घनं तथा कथय पंचघनस्य घनं च मे ।

घनपदं च ततोपि घना त्सखे यदि घनेस्ति घना भवतो मतिः ॥

(¹*Līlāvātī*, p. 20)

रूपत्रयं पञ्चलवस्त्रिभागो योगार्थमेतान्वदतुल्यहारान् ।

त्रिषष्टिभागश्च चतुर्दशांशः समच्छिदौ मित्र वियोजनार्थं ॥

(¹*Līlāvātī*, p. 24)

One of the most remarkable aspects of his teaching style is how he personifies the student in his work. Throughout *Līlāvātī*, he affectionately addresses the learner using words like **bāla** (child), **mitra** (friend), **sakhe** (companion), and **gaṇita-kovida** (mathematical expert)—creating a

welcoming and engaging learning atmosphere. Using these affectionate terms, Bhāskarāchārya made learning an interactive and warm experience, ensuring that students felt encouraged rather than intimidated.

This affectionate teaching mode made learning a joyful experience rather than an imposed task. The opening verses of *Līlāvātī* set the tone for a compassionate and engaging learning experience, demonstrating his emotional connection to the learner.

प्रीतिं भक्तजनस्य यो जनयते विद्मं विनिघ्नन् स्मृत

स्तं वृन्दारकवृन्दवन्दितपदं नत्वा मतङ्गाननम् ।

पाटीं सद्गणितस्य वच्मि चतुरप्रीतिप्रदां प्रस्फुटां

संक्षिप्ताक्षरकोमलामलपदैर्लालित्यलीलावतीम् ॥

(¹*Līlāvātī*, *maṅgalācaraṇam*, p. 1)

This focus on emotional intelligence in education is a timeless lesson, resonating with modern pedagogical theories that emphasise student well-being, engagement, and personalised learning. His approach suggests that when students feel supported and emotionally connected to the subject, they develop a lifelong love for learning rather than just an ability to solve problems mechanically.

★ Igniting Curiosity – Beyond Rote Learning

Bhāskarāchārya's teaching methodology was designed to spark curiosity and encourage students to think beyond standard problem-solving approaches. Rather than merely providing formulas, he structured problems in a way that prompted more profound exploration and pattern recognition.

A striking example of this is his approach to right-angled triangles. Instead of teaching students to find the third side when two sides are given, he presented a method for generating a set of Pythagorean triples for any given diagonal (hypotenuse).

इष्टेन निम्ना द्विगुणाञ्च कर्णा दिष्टस्य कृत्यैक युजायदासं ।

कोटिभवेत्सा पृथगिष्टनिम्नी तत्कर्णयोरंतरमत्र बाहुः ॥

(¹*Līlāvātī*, p. 142)

Mathematically, given a hypotenuse d and an arbitrary number x , he describes a systematic way to determine the other two sides (a and b) of a right-angled triangle:

$$a = 2dx / (x^2 + 1)$$

$$b = ax - d$$

This approach shifts the students' perspective from isolated computations to structural understanding, allowing them to generate multiple right triangles systematically. By making the problem more open-ended and exploratory, Bhāskarāchārya nurtured a natural sense of inquiry, demonstrating how mathematics is not just about applying formulas but also about discovering relationships and patterns within numbers.

★ Encouraging Multiple Approaches to Solutions

Bhāskarāchārya's teaching style is characterised by his flexibility in problem-solving. Instead of enforcing a single method to arrive at an answer, he encouraged students to explore multiple approaches, fostering creativity and more profound intuition.

This pedagogical strength is evident in his approach to finding the square of a number, where he presents different methods rather than a single formula:

समद्विघातः कृतिरुच्यतेऽथ स्थाप्योऽन्त्यवर्गो द्विगुणान्त्यनिघ्नः ।

स्वस्वोपरिष्ठाञ्च तथाऽपरेऽङ्कास्त्यक्त्वाऽन्त्यमुत्सार्य पुनश्च राशिम् ॥

खण्डद्वयस्याभिहितिर्द्विनिघ्नी तत्खण्डवर्गैक्ययुता कृतिर्वा ।

इष्टोनयुग्राशिवधः कृति स्स्यादिष्टस्य वर्गेण समन्वितो वा ॥

(*Līlāvātī*, p. 13)

Here, Bhāskarāchārya describes multiple techniques to compute squares, demonstrating that there is no single rigid way to approach the problem:

- One method uses the identity of $(a + b)^2 = a^2 + 2ab + b^2$, applying it in a structured manner.
- Another method involves choosing a convenient reference number, making calculations easier using algebraic transformations.

Rather than relying on a single approach, Bhāskarāchārya trains students to think flexibly, allowing them to choose the most efficient method based on the problem. By presenting different techniques, he not only made mathematics more accessible and intuitive but also trained students to develop a broader mathematical vision, preparing them for more advanced and abstract thinking.

★ Storytelling – Teaching Through Narratives

Bhāskarāchārya's approach to teaching mathematics was deeply enriched by storytelling, making abstract concepts more engaging and relatable. Rather than presenting problems in dry numerical form, he embedded significant narratives, drawing inspiration from epic tales like the *Mahābhārata*. This method captured students' interest and made problem-solving more intuitive.

A striking example is the following problem from *Līlāvātī*, where he formulates a mathematical puzzle within the context of Arjuna's battle against Karna:

पार्थः कर्णवधाय मार्गणगणं क्रुद्धो रणे संदधे

तस्यार्धेन निवार्य तच्छरणं मूलैश्चतुर्भिर्हयान् ।

शल्यं षड्भरथेषुभिस्त्रिभिरपि छत्रं ध्वजं कार्मुकं

चिच्छेदास्य शिरः शरेण कति ते यानर्जुनः संदधे ॥

(*Līlāvātī*, p. 68)

Enraged in battle, Arjuna shot a volley of arrows at Karna. With half, he countered Karna's attack. He struck the horses with four times the square root of the total arrows. Six arrows slew Śalya. Three arrows struck the

umbrella, flag, and bow, damaging the chariot. Finally, one arrow severed Karna's head. How many arrows did Arjuna shoot?

Rather than simply asking students to compute values, Bhāskarāchārya integrates mathematical reasoning within a dramatic narrative, allowing students to engage logically and contextually. This storytelling method makes mathematical problems feel less abstract and more meaningful, a technique modern educators recognise as an effective way to enhance learning.

★ Poetic Manner – Beauty in Mathematics

Bhāskarāchārya's mathematical treatises are rigorous works of mathematics and remarkable literary compositions, written entirely in flowing Sanskrit verse. His ability to express mathematical principles smoothly, flexibly, and engagingly makes his work stand out.

Unlike conventional mathematical texts, Bhāskarāchārya's verses:

- Maintain a melodic flow, making them easy to recite and recall.
- Use compact and elegant phrasing, conveying deep mathematical insights with remarkable brevity.
- Follow structured meters, ensuring that even young learners can grasp and memorise concepts effortlessly.

His *Līlāvātī*, one of the most celebrated mathematical works, embodies this poetic grace. The very name *Līlāvātī* (meaning “playful” or “graceful”) reflects how effortlessly his verses unfold, making complex calculations feel natural and intuitive. His approach transforms mathematics into an engaging learning experience, almost like a lullaby, ensuring that even students with little exposure to abstract concepts find joy in recitation and understanding.

While other mathematicians have also composed their works in verse, Bhāskarāchārya's rare mastery lies in balancing technical precision with poetic elegance, making his writing uniquely accessible and enjoyable. His works are a testament to how mathematics can become a source of inspiration rather than intimidation when taught with rhythm and beauty.

★ Spirituality – Discipline and Ethics in Learning

Bhāskarāchārya's approach to mathematics was deeply interwoven with spirituality. It reflected the Indian tradition of viewing knowledge as a means to understand the universe and its eternal truths. He connected mathematical concepts with cosmic and philosophical ideas, reinforcing the belief that mathematics is not merely a tool for calculation but a reflection of the divine order.

A profound example of this connection is seen in the following verse from *Bījaganita*:

अस्मिन् विकारः खहरे न राशावपि प्रविष्टेष्वपि निःसृतेषु ।

बहुष्वपि स्यात् ललय-सृष्टिकालेऽनन्तेऽच्युते भूतगणेषु यद्वत् ॥

(*Bījaganita*, 1980, p. 10)

This verse beautifully illustrates the concept of infinity and its connection to the divine. Just as numbers can be repeatedly added or removed from an infinite quantity without altering its essence, so too do creation and dissolution occur in the universe without affecting the eternal, unchanging nature of the divine (Achyuta).

This perspective aligns with the thoughts of Srinivasa Ramanujan, who famously said:

*“An equation means nothing to me unless it expresses a thought of God.”*⁴

For both Bhāskarāchārya and Ramanujan, mathematics was not just a human pursuit but a means to glimpse the infinite and the divine.

Bringing Bhāskarāchārya’s Approach to Modern Classrooms

Bhāskarāchārya’s teaching methods—marked by storytelling, inquiry-based learning, multiple approaches to problem-solving, and contextual learning—offer valuable insights for modern education. His works, composed in verse, engage the learner, promote conceptual understanding, and encourage independent thinking rather than rote memorisation. These timeless principles can be effectively adapted to contemporary classrooms to make mathematics more engaging, intuitive, and meaningful.

Instead of presenting abstract formulas and rules, Bhāskarāchārya often framed problems in engaging mathematical narratives, prompting students to explore solutions independently. A similar approach can be revived in modern classrooms, where lessons are structured as guided explorations rather than rigid instruction.

By integrating his interactive and poetic teaching style, educators today can:

- Replace rigid formula-based instruction with exploratory problem-solving.
- Encourage students to think intuitively rather than rely solely on memorisation.
- Use real-life analogies and storytelling to make mathematical concepts more relatable.

His emphasis on multiple approaches, contextualisation, and engaging presentation makes him a valuable educational model even in the digital age. If adopted correctly, Bhāskarāchārya’s techniques could greatly enhance conceptual understanding, retention, and enthusiasm for mathematics in today’s students.

Challenges and Recommendations

Bhāskarāchārya’s pedagogical methods, though highly effective, present certain challenges when applied in modern classrooms. The current education system prioritises exam performance and standardised curricula, often limiting creative and exploratory learning opportunities. However, thoughtful implementation can overcome these challenges to make mathematics more engaging and meaningful for students.

→ Curriculum Constraints vs. Integration Strategies

Challenge:

- Modern mathematics curricula are structured around formulas, theorems, and rapid problem-solving, leaving little space for storytelling, poetry, and exploratory problem-solving.

- Teachers must cover vast syllabi in a limited time, making incorporating Bhāskarāchārya’s engaging techniques challenging.

Recommendation:

- His techniques can be blended into existing curricula by presenting mathematical concepts in an intuitive, poetic, and exploratory manner.

- Instead of separate lessons, storytelling-based problem-solving can be woven into existing exercises, helping students visualise mathematical relationships.

→ Teacher Training vs. Professional Development

Challenge:

- Many teachers are unfamiliar with Bhāskarāchārya’s works and may find it challenging to adopt poetic and inquiry-based teaching methods.

- Traditional teacher training focuses on procedural teaching rather than interactive, story-driven methods.

Recommendation:

- Workshops and teacher training programs can introduce educators to Bhāskarāchārya’s methods, helping them integrate storytelling, poetic structure, and conceptual discovery into their teaching styles.

- Interactive teaching aids, digital resources, and practical classroom demonstrations can make his methods accessible and easily implemented.

→ Student Mindset vs. Conceptual Learning

Challenge:

- Today’s students are often trained in rote memorisation and may struggle with a conceptual, exploratory approach in which direct answers are not immediately given.

- Learning through poetic problems may initially seem unfamiliar, requiring a shift in how students engage with mathematical thinking.

Recommendation:

- A gradual transition can be made by starting with simple storytelling-based problems before moving to more abstract mathematical inquiries.

- Students can be encouraged to explore multiple solutions, just as Bhāskarāchārya advocated, by presenting open-ended mathematical challenges.

→ Adapting Ancient Methods to Digital Learning

Challenge:

- Bhāskarāchārya’s techniques were designed for oral and written traditions, whereas modern education relies heavily on technology and digital platforms.

- His poetic methods may need modifications to fit into modern digital classrooms.

Recommendation:

- Gamification and interactive digital tools can bring Bhāskarāchārya's style to modern platforms, allowing students to engage with mathematical storytelling through animations, quizzes, and virtual experiments.
- His poetic problems can be incorporated into educational apps where students interact with structured challenges rather than simply memorising formulas.

While adapting Bhāskarāchārya's pedagogical methods to modern education presents challenges, it is possible to integrate his techniques meaningfully. By blending his poetic, inquiry-based, and exploratory problem-solving methods with modern tools and curriculum frameworks, educators can revitalise mathematics learning and create a more engaging, intuitive, and effective learning environment for students.

A Modern Example in Bhāskarāchārya's Style

To illustrate how his pedagogical approach can be used today, here is a problem framed in his poetic and engaging style:

तिष्ठन्ति चाष्टौ विहगास्सुवृक्षे

मिलन्ति चान्ये नव तत्र तुष्टाः।

उड्डीय याताश्चतुरो विहङ्गाः

ब्रूह्यत्र शेषाः कति चोपविष्टाः॥

Eight birds are sitting on a beautiful tree. Nine more birds arrive there and happily join them. Four birds then fly away. Tell me, how many birds remain sitting there?

Why this style works:

- Engages the student with a lively, natural setting (birds on a tree).
- Encourages mental calculation rather than direct application of formulas.
- Promotes curiosity, prompting students to visualise and solve the problem independently.

Conclusion

Bhāskarāchārya's teaching methods stand as a testament to the timeless nature of effective pedagogy. His use of storytelling, inquiry-based learning, poetic presentation, and multiple solution approaches demonstrated a deep understanding of how students learn best—centuries before modern educational theories formalised these ideas. His approach made mathematics more intuitive and engaging, encouraging students to think critically, explore patterns, and develop a genuine love for learning.

In today's education system, where rote memorisation often overshadows conceptual understanding, Bhāskarāchārya's methods offer valuable lessons. By integrating his interactive and explorative teaching style, modern educators can revive the joy of mathematical discovery and inspire students to see mathematics not just as a subject but as a meaningful and beautiful discipline.

Bhāskarāchārya's techniques offer valuable insights into mathematics education by emphasising engagement, conceptual understanding, and multiple approaches to problem-solving. Their application in contemporary classrooms can enhance students' analytical thinking, foster a deeper appreciation for mathematical structures, and encourage creative problem-solving approaches, aligning with modern pedagogical needs. Integrating his methods into modern pedagogy can enrich mathematics learning, moving beyond rote memorisation toward a more intuitive and meaningful experience for students.

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