The Philosophy of Nyaya and Nyaya Methodology: A Lens for Mathematics Learning

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Abstract

This study explores the relevance of Nyaya philosophy, a classical Indian system of logic, epistemology, and debate, as it applies to mathematical learning and research methodology. Rooted in the principles of Hindu philosophy, the Nyaya system offers a structured approach to knowledge acquisition, logical reasoning, and inferential proof that can significantly enhance critical thinking and problem-solving skills in mathematics education. This paper employs a systematic literature review methodology and adheres to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure transparency and rigor. A comprehensive search was conducted across academic databases, ancient texts, and contemporary scholarly works related to Nyaya epistemology and its intersections with mathematical reasoning. The inclusion criteria focused on sources that explicitly discussed logical structures, inference methods, and pedagogical applications relevant to Nyaya philosophy and mathematics. Data were synthesized thematically to identify key philosophical constructs and their applicability to modern mathematical instruction. The analysis reveals that the Nyaya theory of knowledge (pramana), and its emphasis on perception (pratyaksha), inference (anumana), comparison (upamana), and testimony (shabda), provide a robust framework for understanding and validating mathematical proofs. The systematic nature of Nyaya's logical discourse mirrors the deductive reasoning used in mathematical theorems and problem-solving strategies. Furthermore, the study highlights how integrating Nyaya's inferential methods into mathematics education can foster deeper conceptual understanding, logical clarity, and analytical reasoning among learners. It also underscores the importance of preserving and adapting indigenous knowledge systems for contemporary pedagogical practices.

Keywords: Hindu philosophy, mathematical learning, Nyaya philosophy, pramana, research methodology

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Introduction

In the vast landscape of Indian philosophy, Nyaya stands out as a rational and theistic school that emphasizes logical inquiry, epistemology, and argumentation (Chatterjee & Datta, 1984; Radhakrishnan & Moore, 1957). Founded by Gautama Akṣapada around 600 BCE, Nyaya provides a comprehensive framework for acquiring valid knowledge through four primary means known as Pramanas: perception, inference, analogy, and testimony. These epistemological tools form the basis of philosophical discourse and resonate deeply with the methodologies used in mathematics education. The knowledge of the basic philosophies includes six systems of Indian philosophy: Sankhya, Yoga, Vaisheshika, Nyaya, Purva Mimamsa, and Uttara Mimamsa. Among these, the development of Nyaya philosophy is notable for its emphasis on logical reasoning and epistemology, drawing from Hindu philosophical thought while evolving to meet the needs of systematic inquiry (Chatterjee & Datta, 1984). Nyaya philosophy asserts that there is one supreme God and that true happiness lies in union with the divine. It promotes scientific reasoning, mediation between the senses and the self, acknowledging logic and intuition, and rebirth (Hiriyanna, 1993).

Nyaya consists of Tarka *Shastra* (hypothetical reasoning), perception (pratyakṣa), analogy (upamana), inference (anumana), and testimony (sabda), which is connected to methodologies of research and knowledge acquisition (Matilal, 1990). These philosophical tools provide a framework for critical evaluation through inductive and deductive methods, and they are particularly relevant in research methodology within mathematics education. Nyaya's focus on acquiring knowledge through validated means (pramaṇas) can guide students toward deeper mathematical understanding and enhance their analytical thinking skills (Ganeri, 2001). Nyaya philosophy consists of Tarka Sastra, perception, analogy, and testimonium, which are used in Nyaya philosophy and research methodology in mathematics learning. Nyaya is one of the six classical systems of Indian philosophy, and it's important for epistemology and logical reasoning in research methodology. In the Vedas, Nyaya promotes rational and theistic principles, advocating that true happiness comes from union with the divine. It introduces four main methods of valid knowledge (Pramans): Perception, inference, analogy, and verbal testimony. These tools align closely with research methodologies, especially in mathematics education, by encouraging critical thinking and systematic inquiry. Nyaya's philosophical structure supports logic and intuition, making it a valuable framework for enhancing analytical skills in learning and research. As a discipline, mathematics relies heavily on logical

reasoning, deductive proofs, and structured argumentation, all of which are central to Nyaya philosophy. This paper investigates how the principles of Nyaya can serve as a theoretical and practical lens for improving mathematical reasoning and problem-solving skills among learners. Through a systematic review of the literature, we explore the intersections between Nyaya's logical structures and contemporary approaches to mathematics education, emphasizing their potential for fostering deeper conceptual understanding.

Historical Background of Nyaya Philosophy

The word 'Nyaya' is derived from Sanskrit, meaning "method," "rules," or "judgment." It is considered a rational and theistic system, rooted in the Vedas, and is traditionally recognized as part of the Astik (orthodox) schools (Radhakrishnan & Moore, 1957) and one of the six orthodox schools of Hindu philosophy, collectively known as Darshanas. Nyaya philosophy encompasses methods such as hypothetical reasoning (tarka shastra), sensory experience (pratyaksha), comparative understanding (upamana), and verbal testimony (shabda), all of which are integral to research and the pursuit of valid knowledge (Ganeri, 2001; Bhattarai, 2020).

The Nyaya system is particularly notable for its rigorous approach to knowledge validation, making it highly relevant to disciplines like mathematics that rely on proofs and logical consistency. Its emphasis on structured argumentation and inferential reasoning aligns closely with the heuristic and deductive processes involved in solving mathematical problems. Nyaya philosophy is an important school of Indian philosophy that begins with the problem of suffering i.e. *dukkha* (Gupta, 1991). The goal of the Nyaya Philosophy is to enable us to attain the highest goal of life, which is liberation from dukkha and the attendant cycle of births and deaths (Gautama, 1969). Its contribution to Hindu philosophy is the systematic development of the theory of logic, methodology, and rules of epistemology. Nyaya philosophy is associated with logic which is about judgment and understanding.

The Hindu philosophy mainly comprises the six systems of philosophy: Sankhya, Nyaya, Vaisheshika, Samkhya, Yoga, and Mimamsa. The totality of these systems generates specific rules to attain, and the final destination is to remove all the world's sufferings (Bhattarai, 2020). These six philosophical tenets of Nyaya philosophy are especially relevant in the elucidation of the research methodology of mathematics. These methods of validation are called Pramana.

The Nyaya is therefore called the School of Logic (Pangeni, 2024). In Nyaya philosophy, there are four legitimate means of knowledge (Pramaṇa): Direct sensory experience, such as perceiving a geometric shape with the naked eye, is known as praktyakṣa (perception). In proofs, logical deduction is crucial. For example, if all triangles have 180° angles, then a triangle with two known angles can demonstrate the third angle -anumana (Deduction). Comparative learning is a popular method for elucidating complex mathematical ideas- Upamana (Analogy/Comparison). Texts or authority: textbooks or teacher training in schools. It signifies an analytical investigation of mathematics through the process of logical thinking (Radhakrishnan & Moore, 1957).

Nyaya philosophy is one of the six systems of Hindu philosophy. It is important for argumentation and is intellectual, analytic, logical, and epistemological. It signifies an analytical investigation of the subject through the person of logical reasoning. The investigation of meaning or truth through evidence is known as Nyaya (Batsyayan Rishi, cited as Bhattarai, 2020). The metaphysics of Nyaya Philosophy is Tarkashastra (the science of reasoning), Pramanashastra (the science of logic), Hetuvidya (the science of cause), Vadavidy (the science of debate), and Anviksiki (the science of critical study). These elements are essential to research (Pangeni, 2024) and are employed to examine and address mathematical problems.

The Nyaya philosophy's principles, especially its focus on organized argumentation and methodical reasoning, may significantly enhance mathematics learning. Students can better comprehend mathematical ideas by using Nyaya's logical frameworks in the following ways. Structured Reasoning: Constructing and deconstructing mathematical proofs using the five-step inference process (Gupta, 1991); proposition (pratijna), reason (hetu), example (udaharaṇa), application (upanaya), and conclusion (nigamana). By using this approach, students can improve their capacity to methodically build and separate mathematical arguments.

Critical analysis is the process of discussing and analyzing various ways to problem-solving and validate solutions (Vada, Jalpa, Vitaṇḍa). The ability to distinguish between good and invalid reasoning (Hetvabhasa) to stay clear of typical errors in mathematical logic is known as ontological clarity. Nyaya's padarthas, or ontological categories, are generality (samanya), particularity (viseṣa), action (karman), substance (dravya), quality (guṇa), and inherence (samavaya). These categories offer a fundamental framework for developing

mathematical research questions and hypotheses, facilitating a more systematic and thorough investigation of mathematical phenomena.

This paper investigates how the principles of Nyaya can serve as a theoretical and practical lens for improving mathematical reasoning and problem-solving skills among learners. It also highlights the importance of preserving and adapting indigenous knowledge systems for contemporary pedagogical practices. Furthermore, it evaluates the educational usefulness of the Nyaya framework in improving students' mathematical reasoning and examines the use of Nyaya's five-part syllogism in the process of solving mathematical problems. This article attempts to answer the questions: What are the ideas of Nyaya philosophy that have influenced the reasoning and logic system of research? In mathematics, do Nyaya's logical ideas provide instructional advantages? And how does the structure of solving mathematical problems relate to the pancha-avayava?

Methods and Procedures

This study employs a systematic literature review methodology to explore the intersections between Nyaya philosophy and mathematical research methodology, particularly in logical reasoning and pedagogical applications. The review was conducted under the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (Page et al., 2021), ensuring transparency, replicability, and rigor in the synthesis of qualitative evidence. A comprehensive and systematic search was carried out across multiple academic databases: A comprehensive and systematic search was carried out across multiple academic databases: Eric, Google Scholar, ProQuest, PubMed.com, Jstor.com.Nepjol.com, and eric.ed.gov. The following keywords and Boolean combinations were used to identify relevant literature: Nyaya and Philosophy, Nyaya and methodology, Nyaya and mathematics, Nyaya epistemology and education, and logic and mathematical reasoning. These sources were selected to ensure alignment with the study's objective of bridging ancient philosophical insights with contemporary educational methodologies.

Specific inclusion and exclusion criteria were applied during the selection process to ensure rigor and relevance. Inclusion criteria focused on peer-reviewed articles discussing Nyaya philosophy and its relevance to education. The application of Nyaya logic is to mathematical reasoning, and publications exploring comparative or theoretical frameworks linking Indian philosophy

and modern pedagogical practices. Conversely, exclusion criteria were set to eliminate non-academic or opinion-based writings, articles not directly related to Nyaya philosophy or mathematical learning, and duplicates or overlapping publications. Following this structured selection, data extraction was conducted using a standardized coding framework that captured key information such as author(s), year of publication, source, core themes related to Nyaya philosophy, connections made between Nyaya logic and mathematics, and pedagogical implications or applications.

The extracted data were then synthesized thematically to address the central research question: How can the epistemological and methodological insights of Nyaya philosophy inform contemporary approaches to mathematical learning and research? This synthesis facilitated the identification of recurring themes and conceptual linkages, thereby enabling a coherent analysis of the role of Nyaya philosophy in enhancing logical reasoning, critical thinking, and structured problem-solving within mathematics education.

The literature review begins with a discussion of the chosen comparative studies of Nyaya philosophy in mathematics learning after the researcher discusses the findings related to objectives and research questions. Given the nature of the review, only a limited number of articles were accessed, primarily from electronic databases. Future research could broaden the scope by incorporating primary Sanskrit texts, field studies, or empirical classroom interventions grounded on Nyaya-based pedagogies.

Validation and Quality Assurance

The researchers developed a Google Doc containing the initial draft of the review to ensure validity and reliability. The document was shared with peers and subject matter experts for feedback, verification, and cross-checking of key points. Any discrepancies or ambiguities were resolved through consensus and further literature triangulation. Additionally, efforts were made to trace citations and references within selected studies to uncover foundational texts and seminal works in both Nyaya philosophy and mathematics education.

Results of the Systematic Review

Based on the research questions, researchers identified several recurring themes through the review of the literature. Findings are related to ideas of Nyaya philosophy that have influenced the reasoning and logic of mathematics research.

PRISMA Flow Diagram

A systematic literature review on Nyaya philosophy and mathematics learning.

Records identified through database searching
(n=66)

↓

Duplicates removed

(n = 12)

↓

Records screened

(n =54)

↓

Records excluded based on title/abstract

(n = 32)

↓

Full-text articles assessed

(n = 22)

↓

Articles excluded with reasons (e.g., not relevant to Nyaya,
no link to mathematics learning, non-academic sources)

(n = 10)

↓

Included articles in the review

(n = 12)

Table 1

Reviewed Article

S.No	Author's year	Title of Article	Key Themes	Relevance to Mathematics	Methodology	Notes
1	Chatterjee & Datta, 1984	An Introduction to Indian Philosophy	Overview of Nyaya epistemology, Pramana theory, perception, inference	Provides a foundational understanding of logical reasoning relevant to mathematical proof	Philosophical review	Used as the theoretical basis for Nyaya logic in research methodology
2	Radhakrishnan & Moore, 1957	A Sourcebook in Indian Philosophy	Explains Nyaya and its role in rational inquiry, debate, and argumentation	Highlights a logical structure applicable to mathematical reasoning	Comparative philosophical analysis	Cited to support Nyaya as a system of valid knowledge
3	Bhattarai, 2020	Philosophical & Sociological Foundations of Education	Discusses Shodasha Padarthas (16 categories of logic), including Pramana and Prameya	Relevant to structuring research questions and validating mathematical arguments	Theoretical framework	Emphasizes Nyaya's structured approach to inquiry
4	Matilal, 1990	The Word and the World: India's Contribution to the Study of Language	Analyzes Tarka Shastra, inference, and analogy	Supports the use of analogical reasoning in math problem-solving	Conceptual analysis	Highlights linguistic and logical tools for learning
5	Ganeri, 2001	Philosophy in Classical India: The Proper Work of Reason	Focuses on Nyaya syllogism (Pancha-avayava)	Directly linked to structured proofwriting and deductive reasoning in mathematics	Logical interpretation	Used to demonstrate step-by-step reasoning in math
6	Gupta, 1991	Dharmarajadhvarindra	Describes Nyaya inference process: Pratijna, Hetu, Udaharana, Upanaya, Nigamana	Applied to mathematical proofs and problem-solving steps	Deductive reasoning model	Example used in triangle angle sum proof
7	Pangeni, 2024	A Thematic Study of Nyaya Philosophy with Research Methodology	Connects Nyaya methodology to research design and validation	Demonstrates how Nyaya supports systematic research in mathematics	Qualitative synthesis	linking Nyaya to research
8	Scott & Morrison, 2005	Key Ideas in Educational Research	Defines methodology as a means of acquiring knowledge	Helps contextualize Nyaya methodology within educational research	Conceptual discussion	Supports the integration of philosophy into pedagogy
9	Gautama (Nyaya Sutra), 1967	Original Text with Commentaries (Vatsyayana, Uddyotakara)	Foundational text outlining Nyaya logic, inference, and debate	Basis for five-step logical reasoning applied in math instruction	Primary source analysis	Core reference for all Nyaya-based logic
10	Schmidt & Sriraman, 2020	Nyaya Methodology and Western Mathematical Logic	Compares Nyaya logic with Western formal logic systems	compatibility between Nyaya reasoning and mathematical proof structures	Comparative study	Supports cross-cultural relevance of Nyaya in math

Findings and Discussion

Nyaya Methodology: A Framework for Mathematics Research

The methodology of the Nyaya school is a centered or means of acquiring knowledge rather than exploring the nature of knowledge itself (Radhakrishna & Moore, 1957). According to Nyaya, one must be guided by a logical path to truth, which is established through the application of sixteen categories (Padarthas) of logic, often referred to as the Shodasha padarthas (Bhattarai, 2020). These are 1. Pramana (the source of knowledge) 2. prameya (the object of knowledge) 3.Samsya (Doubt or the state of uncertainty) 4.Prayojan (the aim) 5. Dristant (example) 6. Siddhanta (doctrine, principle)7. Ayayava (the constituents of inference) 8. Tarka (Hypothetical argument) 9. Nirnaya (conclusion) 10. Badha (discussion) 11. Jalpa (wrangling) 12. Vitanda (irrational argument) 13. Hetvabhasa (specious reasoning) 14. Chala (unfair reply) 15. Jati(generality) 16. Nigrahsthana (the grounds for defeat). It deals with the form of sixteen categories or Sidharth, which are essential to be known in all aspects. The two categories that are most closely related to mathematics education out of the sixteen are Pramaṇa (valid means of knowledge) and Prameya (things of knowledge). The methodology of the Nyaya School focuses on the ways & means to acquire knowledge & does not delve into the nature of knowledge. One needs to be guided on the path. The logical method of ascertaining the truth is through the application of the sixteen categories of logic. In mathematics, *pramaṇa* refers to techniques like deduction (anumana), perception (pratyaksha, such as the visualization of shapes), and analogy (upamana) that are consistent with Nyaya's focus on reliable sources of information. Mathematics, out of the sixteen, are Pramaṇa (valid means of knowledge) and Prameya (things of knowledge):

Pramaṇa in Mathematics: Nyaya's focus on reliable sources of information is consistent with mathematical reasoning techniques, including deduction (anumana), perception (pratyaksha, such as the visualisation of shapes), and analogy (upamana) (Gautama, 1996). Students can distinguish between assumptions, observations, and logical inferences with the use of these techniques.

Prameya in Mathematics: Nyaya's concern with what is being known or investigated? It is centred on the objects of knowledge in mathematics, which include numbers, shapes, operations, and theorems.

Pramanas (means of right knowledge) and prameya (object of right knowledge) are the most critical ways for our research in mathematics. The sources of gaining the right knowledge are called the Nyaya methodology.

Nyaya's emphasis on debate and critical analysis (vada) helps foster a culture of skepticism and inquiry in teaching mathematics.

Engaging in dialogues that challenge assumptions and explore multiple approaches to problem-solving. It reflects Nyaya's logical methodology, promoting deeper intellectual engagement and a more profound understanding of concepts.

Connecting Nyaya Philosophy with Mathematics Research

Knowledge means jnana/buddhi/perception in the Nyaya Philosophy. The knowledge is true when there is coherence, correspondence and consequence (utility). Methodology means valid knowledge and not the nature of knowledge (Scott & Morrison, 2005). Methodology is the theory of obtaining knowledge in the context of mathematical research. According to the Nyaya school, there are two types of knowledge: Anubhava (experimental) & Smriti (memory). Both categories can be divided into valid & invalid experimental knowledge. Valid experimental knowledge is also called Pramana & invalid experimental knowledge is also called Apramana. Valid experimental knowledge (pramana) corresponds to the thing as it leads to our successful practical activities. Invalid experimental knowledge (Aprama) does not correspond to really and any activity directed towards results in failure & disappointment. Invalid knowledge includes memory (smriti), doubt (samsara), error(viparyaya), and hypothetical reasoning (tarka) (Bhattarai, 2020). A culture of inquiry, scepticism, and cooperative investigation is fostered in the mathematics classroom by the Nyaya system's emphasis on debate(vada) and reasoned discussion. These are especially helpful in the field of mathematics, since Students can examine theories or hypotheses using tarka (hypothetical reasoning) before formal proof.

Valid experimental knowledge (pramana) of mathematics: Pramana is a Sanskrit word that means the source of obtaining knowledge. Pramana is a valid knowledge (prana) received through the Nyaya methodology, or to see Nyaya in the form of pramana is called methodology. What and how is the relationship between the knower and the known? Intuitive, authoritative, logical, and empirical are sources of knowledge (Slavin, 1984). Epistemology accepts four out of six pramana as a reliable means of gaining knowledge. In Nyaya philosophy, Nyaya offers four means to obtain mathematical knowledge. They are: a) Perception (empirical knowledge,. b) Inference (discursive reasoning). c) Analogy (comparison), d) Testimony (inherence), which are important components (Gupta, 1991). They are also essential for research in mathematics. The mathematical knowledge obtained by these four methods is determinate,

categorical, and valid. All the results and investigations are based on these tools and are useful in the field of mathematical research.

The Direct Observation/Perception (Pratyaksha pramana) of mathematics research: Direct perception, or Pratyaksha Pramana, is regarded as one of the most reliable methods of knowledge in epistemology. Perception is essential to the development of actual understanding in mathematical research, particularly in pedagogical approaches. A true cognition that results from the interaction of the cognitive faculties with the external object is called perception. It can be divided into two categories: Alaukik (exceptional) and Laukik (ordinary).

Laukik (ordinary) Mathematics Perception: According to the Nyaya school, Laukik perception is the information produced when the item comes into contact with the sense organs. Ordinary perception deals with six external senses. Such as visual by eyes, olfactory by nose, tactile by skin, auditory by ears, gustatory by tongue, and mental by mind. In the study and teaching of mathematics, when looking at graphs, geometric figures, or animations, visual perception is used. Understanding verbally explained mathematical concepts is aided by auditory perception.

Understanding Classical Logic Systems of Nyaya Philosophy

The process of obtaining reasonable inferences from prior knowledge through observations is known as inference. It is the understanding that establishes cause-and-effect links by using prior experiences to evaluate current occurrences and forecast events to come (Gautama, 1967). Inference is closely related to mathematical reasoning, especially when it comes to solving problems and establishing theorems. According to Nyaya methodology, inference consists of five parts: Pratijna (statement) is a claim that needs to be validated, such as "There is fire on the hill." Hetu (Reason): Evidence to back up a claim, such as "Because there is smoke." Udaharana (Example): A universal relationship, such as "Fire is present wherever smoke is present, such as in the kitchen." Linking the general rule to the specific situation is known as upanaya (application) (e.g., "The hill has smoke associated with fire"). A logical conclusion, such as "Therefore, there is fire on the hill," is known as a nigamana.

Inference is the knowledge that uses the past to comment on the present & predict the future, i.e., gaining the right knowledge from logical conclusions. The nature of this knowledge is to establish relations between the cause and the effect, for example, clouds & rain, fire & smoke. So, inference is also called the Nyaya methodology. Inference has five necessary parts that give knowledge (sources of knowledge): Pratijna (statements), hetu (reason), udharanaa (example), upanaya (universal proposition) and nigamana (conclusion) (Gautam,

1967). It involves a combination of induction-deduction by moving from particular to general vice versa.

Figure 1

Nigamana Exemplified

Example: There is a fire on the hill (Pratijna required to be proved) because there is smoke (called hetu reason).

Whenever there is smoke, there is fire (in a kitchen called udhaharan). Pratijna (statements), hetu (reason). The hill has smoke that is pervaded by fire (upanaya or application).

Therefore, there is a fire on the hill called nigamana (conclusion).

These are sources of gaining knowledge of Nyaya philosophy and research methodology.

Perception is the main source of proper understanding (pramaṇa) in Nyaya philosophy. Based on the kind of contact between the sense organs and their objects, Nyaya differentiates between two forms of perception.

Laukik and Alaukik's Perception of Nyaya Philosophy with Mathematics Learning

A higher or indirect type of perception is known as alaukik perception. Nyaya defines alaukik perception as obtained in three ways: a) samayalakshana- The knowledge which is perceiving generality from a particular object, b) Jnanalakshana- when one sense organ can also perceive qualities not attributable to it, or it is reflected by anubhava. For example, when seeing a chili, one knows that it would be bitter or hot, and c) Yogaja- when certain human beings, through the power of yoga, can perceive past and present and have supernatural abilities (Gautama,1969).

When students generalize mathematical concepts (such as the concept of limit or continuity) from particular examples, this is known as Samanyalakshana (perception of contents). In mathematical research, it serves as the foundation for identifying trends and proving theorems. Knowledge-based perception, or Jnanalakshana, is demonstrated by researchers' or students' intuitive understanding or capacity for the prediction of properties. Students can quickly identify points of maxima or minima by looking at a function graph, for instance, without having to do any math is a process known as "intelligent guessing" based on prior knowledge. When students abstract general mathematical concepts (such as the concept of limits or continuity) from particular examples, this is known as Samanyalakshana (Perception of Universals).

Ogaja (Yogic Perception) is a metaphysical concept that can be broadly understood in mathematics as the infrequent, profound realisation moment that a researcher has following a period of concentrated meditation. Similar to yogic clarity, great mathematical discoveries frequently result from such profound contemplative comprehension.

In mathematical research, it serves as the foundation for identifying trends and proving theorems. Individual students initially understand the concepts through pre-class materials (visual and auditory stimuli). Then, via active in-class debate and problem-solving, they create meaning using both laukik and alaukik perception. The Nyaya epistemology, which supports profound mathematical comprehension and discovery through a combination of direct experience and mental abstraction, is consistent with these perception-based experiences. Pratyaksha Pramana is not just a philosophical concept, it is also a principle that guides the cognitive process of learning and researching mathematics.

The Analogy (Upamana pramana) and Testimony (Sabda) in Mathematics Research

Analogy is the process of understanding a new idea by comparing it with something that is already accepted. Analogy plays an important role in mathematics for gaining intuition, modelling abstract ideas, and resolving word problems. For instance, students can better grasp graph theory by comparing a network of roads to a graph. In the same way that probability distributions mathematically characterize uncertainty, the saying "Life is like a box of chocolates" aids in communicating uncertainty (Gupta, 1969). Testimony is defined as obtaining accurate information from trustworthy written or spoken sources (Schwandt, 2007). This is equivalent to learning mathematics from peer-reviewed publications, teachers, and textbooks. Similar to the axioms

or postulates in mathematics, which are accepted without proof but serve as the basis of further reasoning, Hindu philosophy emphasises the Vedas as self-evident truths. Testimony is also consistent with the contemporary constructivist learning theory, which holds that knowledge is created by students under the direction of reliable professionals.

Thematic Findings

The literature review identified several recurring themes:

Pramana and Mathematical Acquisition

The concept of pramana, or valid means of knowledge, emerged as a central theme. In mathematics, this corresponds to;

Perception (Pratyaksha) – e.g., visualization of geometric shapes or graphs.

Inference (Anumana) – deductive reasoning used in proving theorems.

Analogy (Upamana) – using comparisons to understand abstract concepts (e.g., network theory compared to road systems).

Testimony (Shabda) – learning from authoritative sources such as textbooks, teachers, or axioms.

These methods support not only the acquisition of mathematical facts but also the development of critical thinking and justification skills (Bhattarai, 2020; Ganeri, 2001; Pangeni, 2024).

Nyaya Logic and Problem-Solving Skills

The five-step inferential process of Nyaya (Pancha-avayava) — *Pratijna*, *Hetu*, *Udaharana*, *Upanaya*, and *Nigamana* — was found to be highly applicable in mathematics instruction.

This method encourages systematic reasoning, helping students move from intuitive understanding to formal proof (Gupta, 1991; Ganeri, 2001; Schmidt & Sriraman, 2020).

Implications for Mathematics Education

Integrating Nyaya philosophy into mathematics education offers several meaningful benefits. It promotes structured reasoning by encouraging students to justify each step in problem-solving, which enhances their ability to think logically and systematically. This approach also supports conceptual understanding, moving beyond rote memorization to foster deeper learning and meaningful engagement with mathematical ideas. Additionally, Nyaya's logical framework has cross-curricular relevance, as it strengthens general

reasoning skills applicable across STEM disciplines such as science, technology, and engineering. Furthermore, incorporating Nyaya philosophy brings cultural relevance to the curriculum by validating indigenous knowledge systems within global educational contexts. By grounding mathematics instruction in Nyaya's epistemological and logical structure, educators can better cultivate critical thinking, logical consistency, and conceptual clarity, especially in subjects like geometry, algebra, and calculus.

Comparison with the Western Logic

Nyaya logic shares key similarities with Western formal logic, particularly in its emphasis on deductive reasoning and structured argumentation (Schmidt & Sriraman, 2020). Both systems value clear inference, valid argument forms, and the systematic validation of conclusions. However, what distinguishes Nyaya is its holistic integration of epistemology, ontology, and ethics, offering a broader philosophical foundation for understanding knowledge and truth. While Western logic often focuses narrowly on formal structures, Nyaya provides a more comprehensive view that includes the source, validity, and purpose of knowledge, making it uniquely valuable for interdisciplinary and culturally grounded education.

Practical Applications to Teaching

One of the most effective ways to apply Nyaya philosophy in the classroom is through its five-part syllogism, known as Pancha-avayava. This method can be used to teach structured proof writing, guide problem-solving strategies, help students justify mathematical claims, and improve the logical flow of their reasoning and explanations. For instance, when proving that the sum of the interior angles of a triangle equals 180°, teachers can use the Nyaya framework to guide students through a clear and logical process:

Pratijna (Proposition): "The sum of the angles in a triangle is 180°."

Hetu (Reason): "Because it can be inscribed in a semicircle where the angle at the diameter is 180°."

Udaharana (Example): "A straight line forms an angle of 180°."

Upanaya (Application): "This triangle follows the same principle as the straight line."

Nigamana (Conclusion): "Therefore, the sum of the angles in this triangle is 180°."

By following this structured approach, students learn to articulate their reasoning clearly, validate their solutions logically, and transition from intuitive

understanding to formal proof, ultimately strengthening their analytical and problem-solving abilities.

Conclusion and Implications

The Nyaya philosophy provides a fundamental framework that is particularly important to the study of mathematics because of its emphasis on logic and critical thinking. Mathematical inquiry relies on rigorous proofs, logical reasoning, and a clear methodology to arrive at truth, just as Nyaya distinguishes between true and erroneous ideas and identifies reliable sources of knowledge. As a mulagranth, the Nyaya Sutras lead seekers from apparent reality to ultimate truth; this process is analogous to mathematics, where universal truths are discovered by testing hypotheses, proving theorems, and investigating abstract notions. In this sense, the Nyaya logic system not only promotes philosophical investigation but also motivates a systematic and analytical approach to mathematics, pushing both scholars and learners to go from observation to comprehension and from perception to demonstration. The philosophical underpinnings of the Nyaya technique are similar to those used in modern mathematical reasoning. Analogy (Upamana) improves comprehension through comparisons; testimony (Sabda) confirms information obtained from reliable sources; and inference (Anumana) helps both deductive and inductive reasoning. Pramanas can be successfully included in mathematical research procedures and classroom activities to improve students' conceptual understanding.

Nyaya philosophy is a useful philosophical companion to the mathematical research, discovery, and validation processes in addition to being a tool for metaphysical study.

This study demonstrates that Nyaya Philosophy, rooted in classical Indian thought, offers valuable insights into mathematical reasoning and pedagogy. Its structured approach to knowledge acquisition, logical inference, and critical debate aligns closely with modern mathematical Practices.

The academic and pedagogical value of this study is to further strengthen. Future research should focus on empirically validating the proposed Nyaya-based teaching methods in actual classroom settings. Researchers should also develop assessment tools grounded in Nyaya epistemology to evaluate how well these methods improve student reasoning, comprehension, and problem-solving abilities in mathematics. One effective approach is the use of Pancha-avayava (five-part syllogism) to guide students through structured

mathematical proofs, helping them articulate their reasoning step-by-step. Additionally, encouraging debate and argumentation in the classroom can foster critical thinking and help students validate their solutions through logical discussion and peer interaction. Teachers should incorporate analogy and visual perception, allowing learners to grasp abstract mathematical ideas by relating them to familiar contexts or using graphical representations. Finally, using testimony and authoritative sources, such as textbooks and expert explanations, can support students in building a strong foundational knowledge base and understanding the legitimacy of mathematical concepts.

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