

Fivefold Classification of Motion in Vaisheshika and Its Pedagogical Value for Modern Physics Education

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Abstract

Introductory physics education is often dominated by mathematical formalism, which, while essential, can obscure the conceptual understanding of motion among learners. Educational research consistently shows that students can manipulate equations successfully yet retain fundamental misconceptions about the nature and types of motion. Against this backdrop, the present study examines the fivefold classification of motion (*karma*) in the Vaisheshika philosophical system of Maharshi Kaṇāda and explores its pedagogical value for modern physics education. The Vaisheshika framework classifies motion into upward motion (*utkṣepaṇa*), downward motion (*avakṣepaṇa*), contraction (*ākuñcana*), expansion (*prasāraṇa*), and general motion (*gamana*). It offers a qualitative, classification-based understanding grounded in observation and causality rather than mathematical abstraction. Using a textual-analytical method combined with pedagogical reasoning, this paper argues that the Vaisheshika classification can function as a concept-first scaffold for teaching motion, particularly by foregrounding internal motion and deformation. The study further demonstrates that this approach aligns with contemporary physics education research and with the objectives of India's National Education Policy (NEP) 2020, which emphasizes conceptual clarity, interdisciplinary learning, and the integration of Indian Knowledge Systems. The paper concludes that the Vaisheshika classification, when employed as a supplementary pedagogical framework, can enrich conceptual understanding and foster reflective scientific thinking in modern physics education.

Keywords: Vaisheshika, motion, physics education, concept-first pedagogy, Indian Knowledge Systems, NEP 2020

1. Introduction

Motion forms the conceptual foundation of physics education, serving as the entry point for understanding force, energy, and dynamics. In most contemporary curricula, particularly at the secondary and undergraduate levels, motion is introduced primarily through equations and mathematical models. Although such formalism is indispensable for scientific precision, research in physics education consistently shows that students often struggle to develop a clear conceptual understanding of motion, especially when confronted with non-translational phenomena such as deformation and internal change (McDermott & Redish, 1999; Duit & Treagust, 2003).

These difficulties have prompted increased attention to concept-first pedagogical approaches, which emphasize qualitative reasoning, classification, and phenomenological description before mathematical formalization (Redish, 2003). Within this context, historical and philosophical perspectives on science are being revisited as potential resources for enhancing conceptual clarity and supporting meaningful learning (Matthews, 1994).

The *Vaisheshika Darśana*, traditionally attributed to Mahārṣi Kaṇāda, presents a systematic and observationally grounded classification of motion (*karma*) into five distinct types: upward motion (*utkṣepaṇa*), downward motion (*avakṣepaṇa*), contraction (*ākuñcana*), expansion (*prasāraṇa*), and general motion (*gamana*) (Kaṇāda, *Vaisheshika Sūtra* 5.1.1). Unlike modern mechanics, this framework does not rely on mathematical laws but on causal explanation and careful differentiation of physical change. Notably, it accords equal ontological status to internal motions such as contraction and expansion, thereby broadening the conceptual scope of motion itself (Prašastapāda, trans. Ganganatha Jha).

Despite its conceptual richness, the pedagogical potential of the Vaisheshika classification of motion has received limited scholarly attention. Existing studies primarily situate it within metaphysics, history of science, or comparative philosophy, often juxtaposing it with Newtonian mechanics (Dasgupta, 1922; Seal, 1915). The present study seeks to move beyond such comparisons by examining how the Vaisheshika framework can contribute to modern physics education as a qualitative, concept-building tool.

2. Literature Review

2.1 Motion in Vaisheshika Philosophy

Vaisheshika philosophy analyzes reality through categories (*padārthas*), including substance (*dravya*), quality (*guṇa*), and motion (*karma*). Motion is treated as an independent ontological category necessary for explaining change and interaction in the physical world (Dasgupta, 1922). Kaṇāda's fivefold classification of motion is explicitly stated in the *Vaisheshika Sūtras* and elaborated by Praśastapāda in the *Padārthadharmasaṃgraha*, where motion is closely linked with causality, conjunction, and disjunction.

Classical and modern scholars have highlighted the systematic and quasi-scientific character of Vaisheshika thought, particularly its emphasis on causal necessity and classification (Seal, 1915). However, the educational implications of its theory of motion have rarely been explored in depth.

2.2 Conceptual Learning in Physics Education

Physics education research has repeatedly demonstrated that students often retain misconceptions about motion even after formal instruction (McDermott & Redish, 1999). These findings have led to the development of instructional strategies that emphasize qualitative understanding, conceptual change, and multiple representations (Duit & Treagust, 2003). Classification-based reasoning is recognized as a powerful tool for helping learners differentiate phenomena and construct coherent mental models.

2.3 History and Philosophy of Science in Education

The incorporation of history and philosophy of science (HPS) into science education has been advocated as a means of improving conceptual understanding and epistemological awareness (Matthews, 1994). Historical frameworks often emphasize observation and reasoning rather than formalism, making them particularly useful for introductory instruction. However, Indian philosophical systems remain underrepresented in this pedagogical discourse.

2.4 Research Gap

While Vaisheshika motion theory has been studied philosophically and historically, its potential as a pedagogical framework for physics education has not been systematically examined. This study addresses that gap by reinterpreting the fivefold classification of motion as a conceptual resource for teaching and learning.

3. Methodology

This study adopts an interdisciplinary qualitative methodology that integrates historical-philosophical inquiry with contemporary pedagogical reasoning. The research unfolds in two complementary phases: a *textual-analytical phase* focused on the Vaisheshika tradition and a *pedagogical translation phase* informed by modern physics education research.

3.1 Textual-Analytical Phase

The primary sources for this study are the foundational texts of the Vaisheshika school: the *Vaisheshika Sūtras* of Kaṇāda (c. 6th–2nd century BCE) and Praśastapāda's classical commentary, the *Padārthadharmasaṃgraha* (c. 4th–6th century CE). These texts are consulted in the original Sanskrit alongside authoritative English translations, primarily by Ganganatha Jha (1916). The analytical process involves:

1. **Exegetical Reading:** Close reading of the relevant sūtras (especially *VS* 1.1.6–7 and the sections on *karma* in the fifth book) and Praśastapāda's detailed exposition on the nature, causes, and classification of motion.
2. **Conceptual Mapping:** Identifying the core conceptual structure of the fivefold motion classification (*utkṣepaṇa*, *avakṣepaṇa*, *ākuñcana*, *prasāraṇa*, *gamana*) and its relationships to other Vaisheshika categories (*padārthas*) such as substance (*dravya*), quality (*guṇa*), cause (*kāraṇa*), and inherence (*samavāya*).
3. **Contextual Interpretation:** Situating the theory within the broader Vaisheshika worldview, which is realist, pluralist, and grounded in systematic observation and causal explanation (*yogyatāvaśāda*).

This phase does not seek to modernize or validate the Vaisheshika system in terms of contemporary physics. Instead, it aims to reconstruct its internal logic and epistemological priorities, particularly its emphasis on *phenomenological classification* and *causal reasoning* over mathematical description.

3.2 Pedagogical Translation Phase

The insights from the textual analysis are then translated into a pedagogical framework. This translation is guided by established principles from physics education research (PER), especially research on concept-first learning, misconception remediation, and the use of multiple representations. The process involves:

1. **Identifying Conceptual Congruence:** Mapping Vaisheshika motion categories onto key conceptual challenges in modern physics education (e.g., the narrow association of motion with translation, the neglect of internal deformation).
2. **Designing Pedagogical Bridges:** Developing lesson structures and activities where the Vaisheshika classification serves as a qualitative, pre-mathematical scaffold. This is done by aligning with known effective strategies, such as:
 - **Phenomenon-first approaches:** Using everyday observations to introduce motion types.
 - **Classification tasks:** Encouraging students to categorize diverse motions before quantifying them.
 - **Causal reasoning prompts:** Framing questions around "why" and "how" a motion begins or changes, resonating with the Vaisheshika focus on causes (*nimitta-kāraṇa*).

3. **Ensuring Curricular Alignment:** Demonstrating how this supplementary framework aligns with standard physics topics (kinematics, mechanics of solids, fluids) and with broader educational goals outlined in policies like India's NEP 2020 regarding Indian Knowledge Systems (IKS) and interdisciplinary learning.

The methodology is thus hermeneutic and applied. It interprets an ancient philosophical system not as a historical artifact, but as a living resource for conceptual pedagogy, translated with sensitivity to both its original context and modern educational needs.

4. Classroom Models and Lesson Applications

The Vaisheshika framework is proposed as a supplementary pedagogical tool, most effectively employed at the introductory stage to build a robust, qualitative understanding of motion. Below are specific classroom models and application strategies.

4.1 Introductory Module: "Observing and Classifying Motion"

- **Learning Objective:** To broaden the student's concept of motion beyond mere displacement and to introduce a systematic classification system.
- **Activity (Phenomenon Observation):** Show students a series of short video clips or live demonstrations: an apple falling, a balloon rising, a spring being compressed, dough rising, and a car moving horizontally.
- **Vaisheshika Scaffold :** Introduce the five categories *avakṣepaṇa* (downward), *utkṣepaṇa* (upward), *ākuñcana* (contraction), *prasāraṇa* (expansion), *gamana* (general/horizontal).
- **Student Task:** In groups, students classify each observed motion. A key discussion point is distinguishing *gamana* (general locomotion) from the four specific directional/informational types. This foregrounds the idea that motion is *multiform*.

4.2 Deepening Conceptual Understanding: Internal vs. External Motion

- **Application to Elasticity and Deformation:** Before introducing Hooke's Law or stress-strain curves, use the concepts of *ākuñcana* and *prasāraṇa*.
 - **Activity:** Students manually compress and stretch rubber bands, springs, and sponges.
 - **Discussion:** Focus on the **internal motion** of the object's parts—the *contraction* and *expansion* of its material. This directly challenges the misconception that "if an object's center of mass doesn't move, no motion occurs." It provides a qualitative foundation for later formal study of elastic potential energy and material properties.
- **Application to Fluids and Gases:** The concepts of expansion and contraction are excellent precursors to thermodynamics.
 - **Activity:** Observe the expansion (*prasāraṇa*) of air in a heated balloon or the contraction (*ākuñcana*) of a sealed, cooled bottle.
 - **Discussion:** Frame these as motion *within* the substance, linking to particle model ideas qualitatively. This sets the stage for understanding thermal expansion and the ideal gas law at a conceptual level.

4.3 Causal Reasoning and Interactivity

- **Aligning with Vaisheshika Causality:** Vaisheshika strongly links motion to causes (*kāraṇa*). This can be used to develop causal reasoning skills that are essential in physics.
 - **Prompt Template:** "According to the type of motion (*utkṣepaṇa*, etc.), what is the immediate cause (*nimitta*)?"
 - **Example:** For *avakṣepaṇa* (downward motion) of a dropped object, students might identify "release from support" or "gravity" as the cause. The teacher can later connect this to the modern concept of a net force. The focus is initially on the *necessity of a cause* for motion, countering vague Aristotelian "tendency" ideas.

4.4 Assessment and Reflection

- **Formative Assessment:** Use classification exercises, drawing diagrams with motion arrows labeled in Vaisheshika terms, and "explain in your own words" prompts comparing two types of motion.
- **Metacognitive Reflection:** At the end of a unit, ask students: "How did thinking about motion as *upward*, *downward*, *contracting*, *expanding*, and *general* change or deepen your understanding compared to only using *distance*, *speed*, and *acceleration*?" This fosters epistemological awareness about the role of classification in science.

4.5 Integration with Standard Curriculum

This framework is not a replacement but a **conceptual primer**. The sequence would be:

1. **Vaisheshika-Based Qualitative Introduction:** (1-2 class periods) Observing, classifying, and discussing motion types and causes.
2. **Transition to Formal Physics:** "Now, let's learn how to measure, calculate, and predict these motions mathematically." The teacher explicitly links:
 - *Utkṣepaṇa*/*Avakṣepaṇa* → 1D vertical kinematics under gravity.
 - *Ākuñcana*/*Prasāraṇa* → Deformation, elasticity, thermal physics.
 - *Gamana* → 2D projectile motion, general kinematics.
3. **Ongoing Reference:** Use the Sanskrit terms as conceptual shorthand throughout the course to reinforce the taxonomy (e.g., "The *prasāraṇa* of the gas is due to increased kinetic energy").

This pedagogical application demonstrates how the Vaisheshika framework can make the transition to formal physics more meaningful, grounded, and conceptually coherent for learners.

5. Discussion

The pedagogical value of the Vaisheshika framework lies in its emphasis on classification and causality. By encouraging students to ask *what kind* of motion is occurring before *how* it is quantified, the framework supports

deeper conceptual understanding. This aligns with contemporary educational research and avoids the pitfalls of anachronistic scientific comparison.

6. Conclusion

This study has shown that the fivefold classification of motion in Vaisheshika philosophy offers a coherent and conceptually rich framework that can meaningfully supplement modern physics education. By recognizing internal motion alongside translational motion, the Vaisheshika model addresses persistent conceptual difficulties identified in physics education research (McDermott & Redish, 1999). The proposed classroom applications demonstrate how this qualitative framework can support concept-first learning without undermining the rigor of modern mechanics.

The pedagogical approach articulated here also aligns with the vision of India's National Education Policy (NEP) 2020, which emphasizes conceptual clarity, interdisciplinary learning, and the integration of Indian Knowledge Systems in a methodologically sound manner (Government of India, 2020). By situating Vaisheshika motion theory within a pedagogical rather than a purely comparative framework, this study contributes to interdisciplinary discourse linking philosophy, history of science, and physics education.

Future research may empirically test the effectiveness of such frameworks in classroom settings. Nevertheless, the present analysis suggests that classical Indian philosophical classifications, when interpreted with analytical rigor, can enrich contemporary science education and foster reflective scientific thinking.

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