# Imaginative Embodied Forms of Expression in Macroscopic Physics for K-6 Teacher Education

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**Abstract.** When we directly (physically) encounter Forces of Nature such as Wind, Light, Heat, or Water, the embodied gestalt of a powerful entity forms in our mind. This gestalt is characterized schematically and elaborated metaphorically and analogically, which allows for the construction of imaginative forms of communication supporting concept formation. Examples of forms of expression include natural language stories, bodily mimesis, art, and mathematics. Here, we discuss the use of bodily mimesis in the form of Forces-of-Nature Theater performances, and stress the importance of integrating mimetic expression with other forms of communication (i.e., using polysemiosis) for substantial learning to occur.

## An imaginative approach to encounters with Forces of Nature

In recent years, we have been building the (formal) scientific, cognitive, pedagogical, and didactic foundations for Primary Physical Science Education (PPSE, [1]) and applied them to a course for K-6 teacher education [2]. The imaginative approach to theories of macroscopic physical science presented here rests upon three main premises: (1) theories of macroscopic physics—such as continuum physics and the physics of uniform dynamical systems—are theories of a small number of Basic Forces of Nature (B-FoN: Fluids, Electricity & Magnetism, Heat, Substances, Gravitation, and Rotation and Translation) [3]; (2) the conceptual basis of these theories is rooted in embodied experiencing [4-6] and is fundamentally imaginative (schematic/ abstract, metaphorical, analogical, and narrative) [7-8]; (3) in the interaction of direct physical and communicative experiencing of Primary Forces of Nature (P-FoN: Wind, Fire, Light, Water, Heat & Cold, Thunder & Lightning, Magnetism, Motion, etc.) by children, the schematic elements of thought and understanding needed for later embodied and imaginative engagement with more formal approaches to physical science are laid. Furthermore, creating learning environments where direct physical experiencing of P-FoN can interact with one or several imaginative forms of expression (such as natural language stories, bodily mimesis, art, and mathematics) is central to the concrete pedagogical and didactic designs created in PPSE.

## Interacting imaginative forms of expression (polysemiosis) and learning about FoN

If we ask how young learners' encounters with P-FoN can lead to schematic abstractions and metaphorical and analogical conceptualizations needed for later understanding of B-FoN, we can point to cognitive science that demonstrates the importance of embodied experiencing in general and the interaction of different forms of such experiencing in particular [1]. This means that we give learners—including teachers in training—the opportunity to let direct physical experiencing of Forces interact with different forms of human expression. We have actively explored the interaction of physical encounters with Forces and the use of stories of FoN [9]. Here, we want to sketch what it means to add another form of expression—bodily mimesis—to the list of didactic activities [10].

Bodily mimesis—usually performed as gesture, pantomime, or theatrical play—is a form of human expression arising early in both phylogeny and ontogeny (and may well be a steppingstone toward natural language development, [11-12]). We have made use of a particular mimetic form of expression by developing Forces-of-Nature Theater performances ([1, Chapter 5], [10]), which

are combined in a polysemiotic setting with stories and direct physical experiencing of a small number of FoN. We often choose Wind as the first of these Forces to be studied. Direct experience of Wind typically lets a gestalt arise in our mind that is characterized by just a very few basic aspects, namely, intensity (and its differences), (spatial) extension, and power. We can suggest to learners to use our bodies for representing such a gestalt and use bodily mimesis for expressing our understanding of the characteristics of a Force.

We then study the interaction of Wind with Water or Electricity—such as in historical windmills or modern wind turbines—where the first of the Forces (Wind) is the agent pumping or activating a patient (Water or Electricity, respectively). The FoN-T performance involves two groups of actors, one for each of the Forces. Wind actors are initially tense and energetic; as they interact with Water or Electricity actors, they become tired (relaxed) and leave the area of interaction. In response, the patients will be tensed (become "energized"). In a performance suitable for primary school students, we can represent energy by some mass-like stuff (such as confetti) that will be carried and brought to the scene by an agent and handed to one or more patients. Consequently, a patient is "energized" and leaves the scenery (i.e., the windmill or wind turbine) with the energy it has received.

Bodily mimesis enables forms of embodied logic, which greatly supports learning about intensive and extensive concepts of a Force and the role of energy in macroscopic systems and processes. Importantly, a chosen form of experiencing should always be combined with other forms—such as storytelling allowing for narrative experiencing—in order to lay the foundation for conceptual understanding.

## References


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