

# When Words Are Not Enough: What Student Gestures and Embodied Responses Tell Us About Understanding Science Through Dance

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**Abstract:** First and second grade students in a technology-based immersive learning environment collaboratively created and performed dances as an embodied form of sensemaking to reinforce scientific learning. Providing verbal and gestural feedback on a dance synthesized embodied, enactive, and cognitive practices. Students watching dances used gesture where their vocabulary was no longer adequate to describe their scientific understanding. We argue that legitimizing multimodal forms of expression expands on students' collaborative reasoning tools.

## Introduction

First and second grade students at the [School] participated in a seven-day unit of study exploring states of matter using technology, play, and embodied forms of inquiry and representation. The final day asked students to create and perform dances showing a designated state change (e.g. liquid to gas), while their peers watched the performance and tried to guess which state change they performed. The dances were used and viewed as cultural artifacts that supported and deepened science learning and inquiry. Building on research that recognizes the role the body plays in sense-making and the role of gesture in social interactions (Goodwin, 2018; Goldin-Meadow, 2004), this poster positions dance as part of an embodied science learning approach that expands students' available reasoning tools. We claim students presented understandings of micro- and macro-level phenomena in their dances, and relied upon gesture and embodiment to fully express their understanding of complex science ideas during discussions.

## Methods

iSTEP—interactive Science through Technology Enhanced Play—is a multi-year design-based research study (Design Based Research Collective, 2003) exploring scientific inquiry through embodied play. We used inductive methods and interaction analysis (Jordan & Henderson, 1995) to analyze video data from two classrooms of 25 6-8 year-olds, working with two teachers. Students engaged with ideas of water particles on a macro level (e.g. water vapor is gas), and on a micro level (e.g. particles in a gas move quickly). A researcher led the final day, where students choreographed dances demonstrating a state change in groups, performed them, and gave and received feedback on their dances as a means of integrating their understanding of how both micro (particles) and macro (observable) levels engage concurrently.

## Findings and analysis

Dance challenged students to engage in reasoning strategies in both choreography and as while viewing their peers' dances. First, we present students demonstrating simultaneous understanding of macro and micro particulate behavior physically through dance. Students collaboratively engaged in multimodal forms of expression to simultaneously represent particulate behavior as water particles in liquid, and as water (Figure 1).

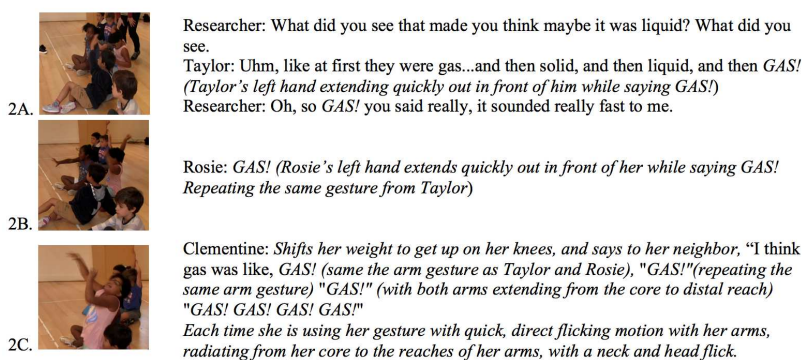


Figure 1. Students simultaneously represent macro and micro particulate matter of liquid with their bodies.

Students represented water at a macro level by using “curvy” lines in their bodies including a rounded spine and articulations of the wrist and arms. Students showed the micro-level by demonstrating the spacing (close together) and movement (slow) of liquid water particles. This dance presented their understanding of the particulate behavior of water laminated (Goodwin, 2018) upon their understanding from lived-experience of macro-water behavior. We see these movements explored during choreographing and performing a dance as supporting

sensemaking at both micro- and macro-levels through dance and conversation. We suspect that their exposure to MR technology and invitation to choreograph a dance supported their ability to move freely and present their understanding of the states of matter with their bodies across both levels. A complex task was accomplished because dance and the body were accessible as reasoning tools to support sensemaking and representation.

We also analyze student observers engaging with multimodal forms of expression to support understanding content knowledge in response to their peers' performances. It is important to note that even though some students had not yet presented their dance, all students had already choreographed and practiced their dances. After watching a group perform, the audience members guessed that liquid was represented in the dance (Figure 2).



**Figure 2.** Students discuss a group's dance.

When prompted to describe why he thought the dancers were evoking liquid, a student stated, "Uhm, liquid because they were going slow when they got there, was kinda like a wave." At this point, Rosie said, bu-bu-bu-shhhhhh (wave noise with wave arm movement; Figure 2B), and Clementine said, "that reminded me of a wave...good..." and generated her own wave movement with her arms (Figure 2C). In this moment, students articulated scientific concepts with a combination of words and gestures, communicating with more rigor than they had previously managed with words alone. We argue that these physical embodiments are different than gestures studied previously (Goldin-Meadow, 2004) in that students engaged in this process are utilizing multimodal forms of expression and representation informed by their own experiences of choreographing dances, engaging with the mixed reality visualization, and grappling with the scientific content verbally with peers in small and large group discussions.

## Discussion and Implications

The instances presented in which student movements simultaneously instantiated micro and macro levels of systemic behavior indicated that talking about scientific phenomena was challenging, but the body could accomplish simultaneous, laminated, multi-leveled movements where linear words currently fail them. Current literature positions embodiment as a tool for sensemaking (Wilson, 2002), and gestures as important in communication and meaning making by emphasizing as well as building new meaning (Goodwin, 2018). Here we argue that choreographing, performing, and watching classmates perform dances demonstrating scientific concepts supported understanding of the science curriculum by privileging both linguistic and embodied sense-making. The data we present show evidence of the body leading the sense-making process in rigorous scientific inquiry. In future work, we want to explore how this process leads to deeper scientific inquiry that supports the development of representational knowledge, embodied sense-making, and understanding science through dance.

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