EXPLORING MIDDLE SCHOOL STUDENTS’

EMBODIED CONCEPTIONS OF THE MECHANISM OF THERMAL CONDUCTION AND ITS IMPLICATION FOR INSTRUCTION

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ABOUT THE PROJECT

GRASP
Gesture Augmented Simulations for Supporting Explanations

• Gesture Augmented Simulations for Supporting Explanations

• http://grasp.education.illinois.edu/

NSF

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The Concord Consortium
• Energy is a Core disciplinary idea of Next Generation Science Standards (NGSS Lead States, 2013)

• Research on students’ conceptions about heat have revealed that everyday experiences prevail over scientific explanations (across age groups) (Erickson, 1979; Kesidou & Duit, 1993; Schnittka & Bell, 2009)
  • Heat is hot or warm
  • Heat is a “mysterious entity with the essential property of hotness that can propagate through” (Wiser & Amin, 2001, p. 335)
  • Temperature is a degree of hotness
• What are middle school students’ embodied ideas about heat transfer within a spoon?

• In what ways do their gestures interact with the construction of an explanation of thermal conduction?
An imagistic mental model in which the student visualizes the interactions of unobservable elements such as molecules to explain why observable phenomena happen (Ahn, Kalish, Medi, & Gelman, 1995; Brown, 1993; Cheng & Brown, 2015)
Why does the handle end of a spoon get hot when only the bowl end of the spoon is dipped in hot water?
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Movement of the arms and hands closely synchronized with the flow of speech 
(McNiel, 1992)

Gestures are evidence that knowledge itself is embodied 
(Alibali & Nathan, 2012; Goldin-Meadow, 2011; Roth, 2001)
Computer generated, dynamic model of the real world and its processes (Smetana & Bell, 2012)

Simulations are flexible, adaptable and simplistically represent complex and abstract phenomena (Hilton & Honey, 2011; Smetana & Bell, 2012)
METHOD
1. 24 middle school students interviewed
2. Semi-structured interview
3. Coding and analysis
   - Created canonical explanation
   - Created codes from this explanation
   - Identified student’s explanations
   - Coded for presence of explanatory elements
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METHOD

1. Spoon is made of molecules
2. Molecules are dynamic elements
3. Molecules interact with one another
4. Hot means faster moving molecule
5. Cold means slower moving molecule
6. Faster moving molecule BUMPS into slower moving molecule
7. Chain reaction of collisions
While coding the interviews, a consistent set of explanatory ideas emerged

1. **Steam** heats the handle of the spoon
2. Metal is a good **conductor**
3. Heat is an **entity** that goes through the spoon
4. Heat moves like a **wave** through the molecules of the spoon
5. Heat is caused by **friction** between molecules

Some students verbally stated these ideas, but in many cases, attending to **gestures** provided further insight into these conceptions
FINDINGS

Heat is an entity that goes through the spoon

Andrew: Well...if I'm right the spoon is like a silverish color...metal
Heat moves like a wave through the molecules of the spoon

Jane: Yeah. So, kinda like in the simulation, when the bowl is placed in the hot water, the
Other interactions with explanation:

When we noticed student’s using gestures while explaining, we asked them to use their hands while they explained
Andrew’s final explanation

Andrew: Well, when you put the bowl in, the molecules in the bowl
FINDINGS

• Andrew’s growth in understanding is made visible through his representational gestures

• Explicit requests to “show” gestures reveal nuances of understanding not mentioned before

• Drawing attention to conceptually-grounded gestures may make them more salient to the learner
FINDINGS

Making collisions visible to Ulani

Interviewer: So these you're saying these molecules will start moving faster. Right?
IMPLICATIONS

- Representational gestures can reveal deeper conceptual ideas.
- Attending to gestures (as teacher and learner) can make abstract interactions more salient to the learner.
- Simulations taking gestural feedback may be a helpful resource for developing mechanistic explanations in science.

Blake taps his fingers to show molecules colliding and a chain reaction happening.

Using Leap Motion device to detect hand gestures in simulations.
REFERENCES


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http://grasp.education.illinois.edu/publications/