

## **Gesture-Speech Mismatch in Engineering**

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Gesture co-occurs with speech during explanations (McNeill, 1992). Student gesture research in engineering is limited. However, gesture has been studied in mathematics (Alibali & Nathan, 2012) and in geosciences (Atit et al., 2015) education. Observation of gesture-speech mismatch indexes transitional states of knowledge (Church and Goldin-Meadow, 1986; Goldin-Meadow et al., 1993) indicating readiness to learn new concepts, as well as revealing engineering misconceptions demonstrated verbally (Case 1) and gesturally (Case 2) during laboratory learning.

An exploratory study in an engineering lab provides insights into gesture-speech mismatches to improve formative assessment. Students (N=4) collaboratively discussed pre-lab questions prior to a torsional experiment. During pure torsion, distal forces cause rotation about a metal rod's central axis without making the diameter shrink ("necking") or expand ("bulging"), from a perpendicularly applied force. Gesture and speech were coded using grounded theory (Muller, 2014). Findings revealed misconceptions in gesture-speech mismatches.

Case 1 (gesture codes are identified in square brackets): "...if it starts necking ...that will tell you right away that it's not going to shear [Rotational-Loading and Unloading]..." The relevant science involved is that samples do not neck under pure torsion.

Case 2: "I'd say if it was on the exact neutral axis [Geometrical Shape], it wouldn't [Rotational-Loading and Unloading], it's not moving there, right?" The student makes Rotational gestures of torsion even though the neutral axis remains stationary indicating a misconception that would be missed based on speech codes alone.

Gesture-speech mismatches can reveal engineering misconceptions. Instructors trained to notice gestures can correct students' situated misconceptions by aligning inaccurate verbal explanations (Case 1) with correct gestures or incorrect gestures (Case 2) with correct verbal

explanations. Caution is necessary, however, since students draw from various experiences and spatial representations when hypothesizing through gesture and co-speech that may signal correct, yet different, conceptualizations from expert hypotheses.