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Theories and Practices of Emotion, Movement, and Embodiment in Mathematical Learning

Will Lee

Sai Gattupalli

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Research Advisor: Professor Ivon Arroyo Consultation: Professor Jeanne Brunner

Will Lee williamlee@umass.edu
Sai Gattupalli sgattupalli@umass.edu

UMassAmherst | College of Education

Abstract

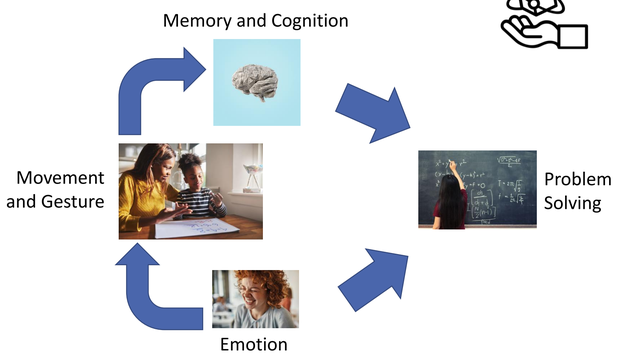
- Physical movements, emotion, and embodiment are fundamental to mathematical learning.
- Problem: Lack of study in collaborative embodiment.
- Identified applications of embodiment using virtual reality. An exploratory analysis of a set of videos for an embodied mathematical game was conducted.

Objectives

1. Show embodiment – specifically emotion, bodily movement, and gestures – are linked together during mathematical learning.
2. Demonstrate tools and methods to identify indicators of embodiment.

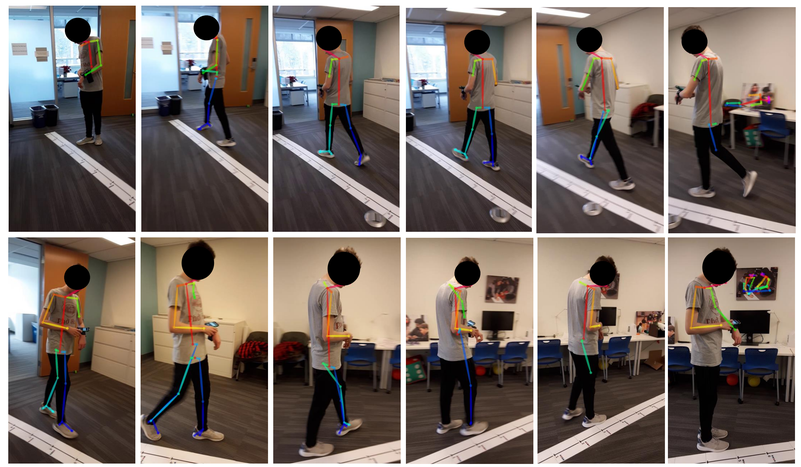
Theories

- Abrahamson et al. (2020) discussed that movement and gestures are fundamental in learning, understanding, and generalizing mathematical concepts - also known as Action-Cognition Transduction.
- Gestures enabled students to perform better in reasoning and proofing.
- Multi-party gestures led to higher learning gains than individual gesturing.

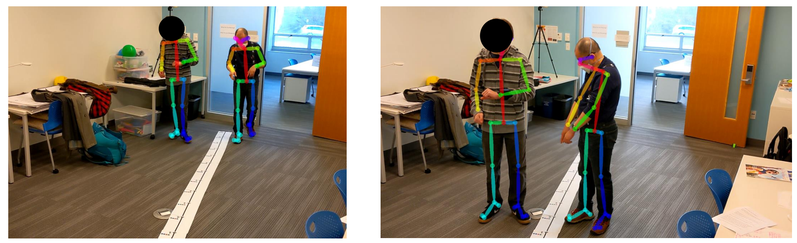


Exploratory Analysis*

Learn number line through walking individually



Learn number line through walking collaboratively



Learn number line while having fun!

*Explored DeepLabCut, YOLO, and finally analyzed using OpenPose

Applications

Immersion not only increases the sense of presence, but also enhance students' engagement, sense of agency, and learnings.

- Planey et al. (2022): used gestures spontaneously to assist each other in identifying star and constellations. Participants communicated, shared knowledge, and established common ground all through gestures.
- Chatain et al. (2022): learned derivative through direct manipulation of curves and points. Their findings identified that considering design options are important to facilitate learnings.
- Johnson-Glenberg et al. (2021): Levels of embodiment, degree of agency, and engagement are important in virtual reality.

Discussions & Future Work

- Without agency, engaging activities, or emotional support, learning will be bland, sad, and boring.
- Learning in mathematics is multimodal – physical movement, emotion, utterances – and occurs both individually and collaboratively.
- Future

1. Correlate physical movements with log data such as mastery.
2. Apply language models to generate hints and emotional support dynamically.
3. Create machine learning models for automatic recognitions.