A Body of Work: Research & Design of the Hidden Village, a 3D Motion-Capture Game

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SMU

ABSTRACT

The Hidden Village (THV) is a multi-year design-based research project that has developed a 3D-motion capture video game for geometry instruction & learning. The augmented nature of THV enables learners to leverage their body as a means for understanding the spatial relationships that underlie geometric conjectures.

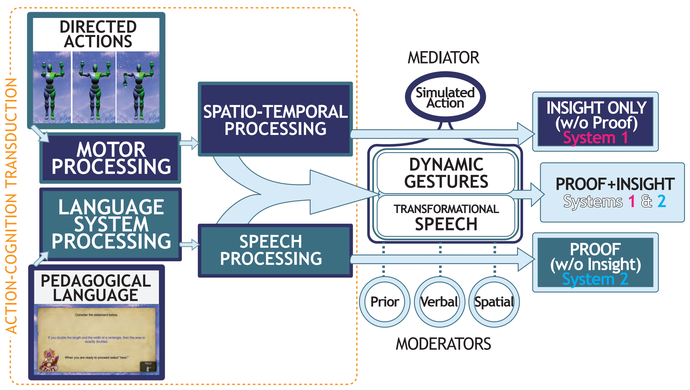
The latest version also brings important pedagogical and motivational considerations like players' agency and ownership of their experience, the ability to collaborate with peers, and allowing players to author, design, construct, test and publish their own levels of the game. By providing authoring tools in THV, students and teachers can customize content to align with curriculum, connect to real-world applications and maximize the game's effectiveness in classrooms.

THEORETICAL MODEL

ACTION-COGNITION TRANSDUCTION

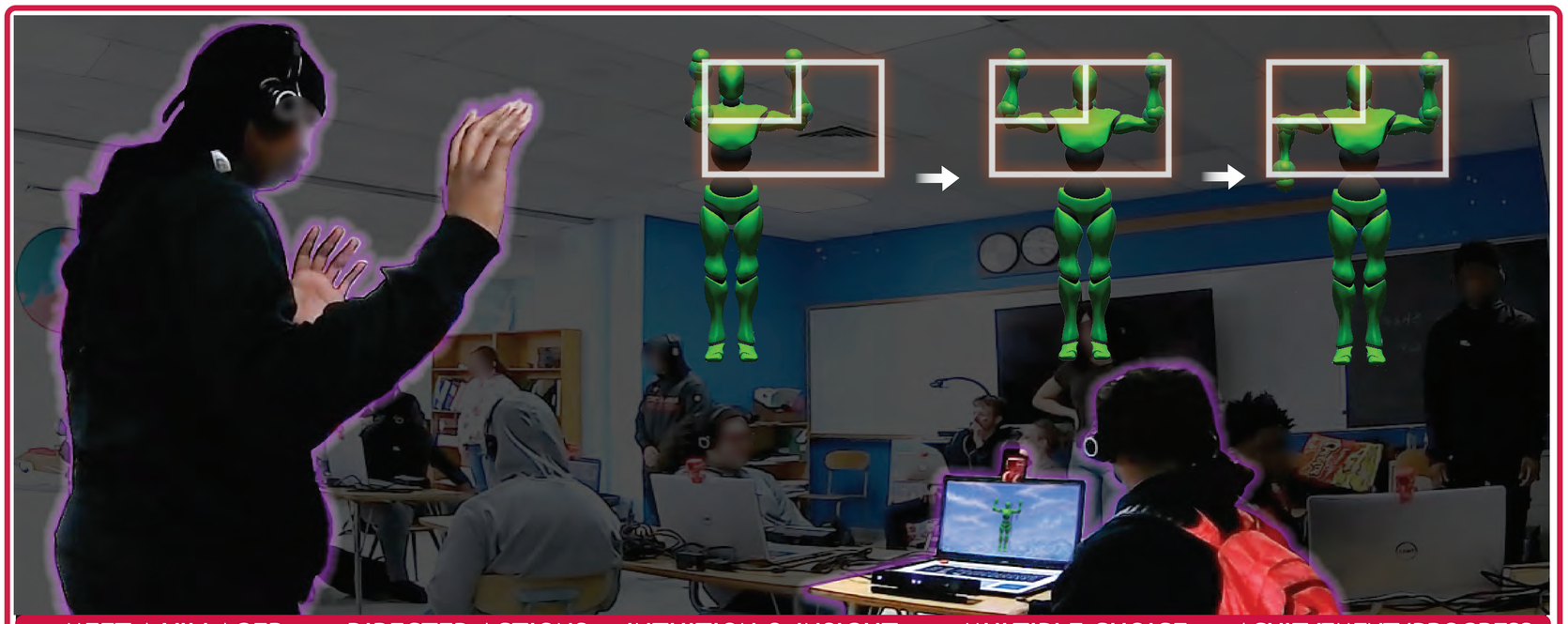
Movement stimulates the motor system concurrent to the language & speech processing system, processing, in parallel, the electrochemical signals that transduce perception into conception.

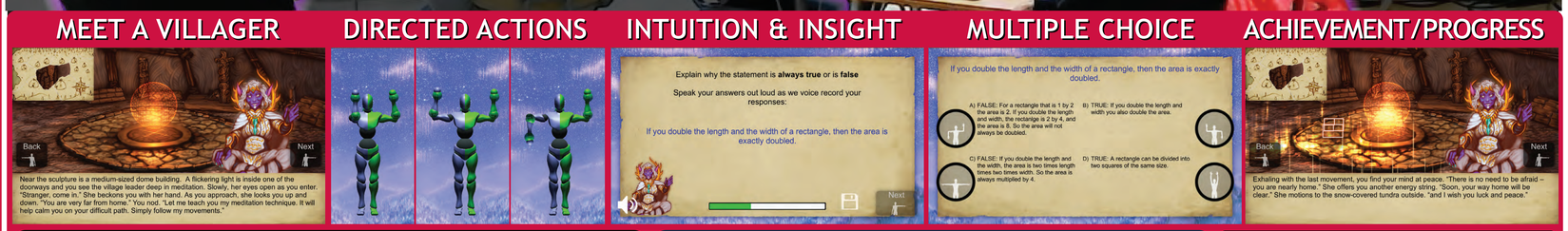
THV LOGIC MODEL

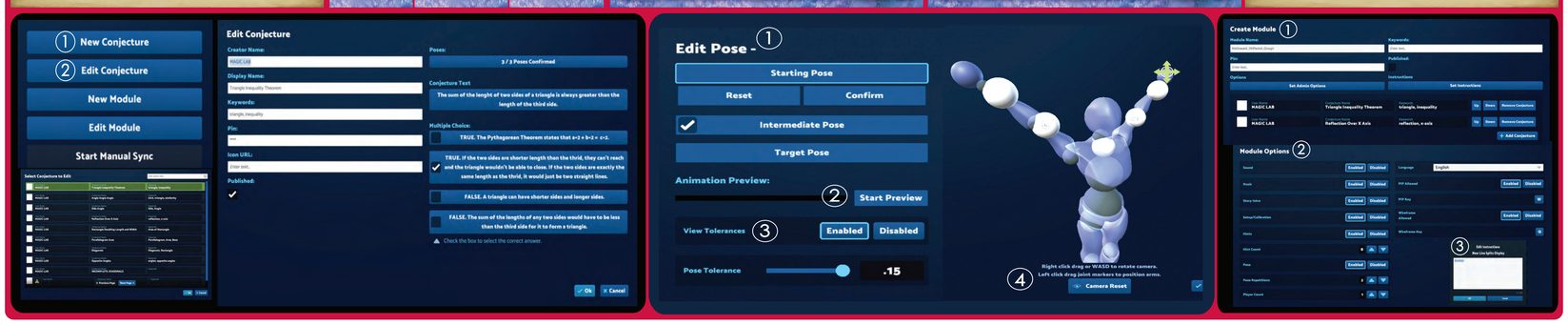


LEARNING OBJECTIVES

(1) **Intuition** - snap judgements of math correctness
(2) **Insight** - general thoughts (i.e., gists)
(3) **Transformational Proofs** (Harel & Sowder, 2005)
  (a) *Generalizable* — true for a class of mathematical objects;
  (b) *Operational* — progressive goal structure, anticipating transformations;
  (c) *Logical* — drawn from valid premises.

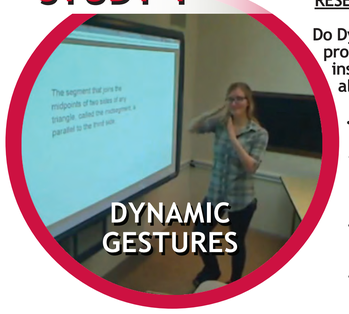






RESEARCH

STUDY 1

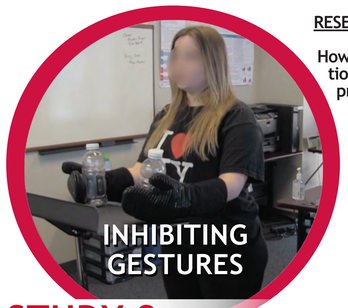


RESEARCH QUESTION #1:

Do Dynamic Gestures promote better insights transformational geometric proof?

- **N = 90** (UW Novices vs. Experts)
- **Spatial reasoning** and **dynamic gestures** predict intuition, insight & informal proofs
- Above & beyond expertise and speech
- Dynamic gesture 'replaces' spatial reasoning (*d*=1.11)

STUDY 2



RESEARCH QUESTION #2:

How does gesture inhibition affect geometry proof performance?

- **N = 108** (SMU Undergraduates)
- Performing **any gesture** and **dynamic gestures** each predict insight & informal proofs when inhibited
- **Dynamic gestures** appear to be a biproduct of geometric reasoning

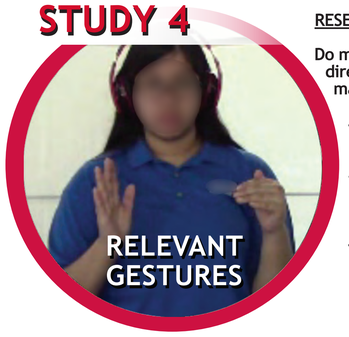
STUDY 3

RESEARCH QUESTION #3:

How does pedagogical language interact with directed actions to influence the formation of transformational proof?

- Students **incorporated** the **directed actions** into their explanations for proof.
- In a few case studies, **after** receiving **hints**, student's gestural **depictions** changed from **static** to **dynamic** respresentations of the geometric space

STUDY 4



RESEARCH QUESTION #4:

Do mathematically related directed actions affect mathematical reasoning?

- **N = 85** (first-gen college bound high school students)
- Mathematically related directed actions were helpful so long as students made some gestures
- Within subjects showed a reliable advantage for making mathematically relevant gestures duing game play

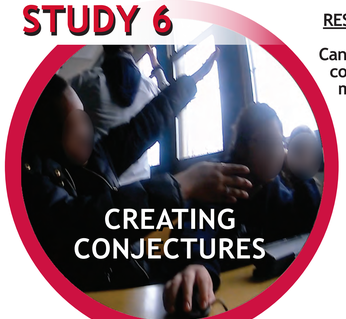
STUDY 5

RESEARCH QUESTION #5:

What is the influence of producing actions v. observing actions on geometry reasoning?

- **N = 115*** (High School Students)
- A case study of linguistically diverse all LEP-classroom
- Gestures transcended natural language barriers between students
- Gestures transcended mathematical language barriers
- Students incorporated directed actions in to their co-speech gestures

STUDY 6



RESEARCH QUESTION #6:

Can students co-create new content for embodied geometric reasoning?

- *In situ* pilot (**n = 11**) show that students can collaboratively co-create gestures (directed actions) for peer learning
- Full *in situ* study (**n = 150***) currently underway with collaborating team in Dallas, TX

REFERENCE:

Nathan, M. J. & Walkington, C. (2017). Grounded and embodied mathematical cognition: Promoting mathematical insight and proof using action and language. *Cognitive Research: Principles and Implications*, *2*(9).

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GEAR

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