ISGS 2022 Abstract Action Geometry

**Theme**: gestures along four interacting dimensions: description, function, mechanism, and application

Submissions: We invite abstracts of no more than 300 words (**2150 characters**). Abstracts must report previously unpublished work. Each author may submit no more than three abstracts as first author.

- Individual papers. Paper presentations will be 15 minutes (12 minutes for the presentation and 3 minutes for discussion)
- Poster presentations. Poster presentations are an opportunity for more extended interaction. Poster sessions will be one-hour each, and will encourage ample one-on-one discussion of novel research findings.

Title: Gesture production in geometry proof practices and education: Description, function, mechanism, and application to a digital embodied learning environment

ABSTRACT

Proof is a core math practice. Students' primary exposure to proof occurs in high school geometry, which is steeped in abstractions and formalisms intended to make universal claims about shape and space that go beyond one's personal experiences. We present findings synthesized across five empirical studies of high school and college students engaged in individual and collaborative geometric reasoning and proof (N=346). They reveal each of the four interacting dimensions of gesture for investigating and cultivating mathematically valid geometry proof practices.

The **description** reveals that successful proofs of both experts and non-experts include *dynamic depictive gestures* that students use to enact generalizable properties of shape and space through transformational operations (e.g., dilation, skewing) on mathematical objects.

*Action–cognition transduction* (ACT) is hypothesized as a **mechanism** by which goal-directed body movement within a predictive feedforward/feedback architecture can induce mental states in a manner reciprocal to how cognition drives action. Students' socially mediated gestures in collaborative contexts is a **mechanism** used to establish common ground and shared meaning construction among learners to support the emergence of extended mathematical knowledge and distributed representations across multiple bodies.

Dynamic gestures **function** to support students' simulated actions of mathematical transformations for hypothesizing, testing, and generalizing universal truths about space and shape for themselves. These gestures often reoccur spontaneously as catchments in students' verbalized proofs used to persuade others

**Application** of these four interacting dimensions of gesture production are instantiated in *The Hidden Village* (THV), an embodied, digital learning environment that uses the narrative context of a visual novel. THV is used to in controlled experiments and classroom-based research to investigate the influence of individual and collaborative movement on mathematical thinking and learning, and to assess students' nonverbal and verbal ways of knowing.