

# Tangible Modeling Over Distance:

## Using Computer Vision to Support Distal Collaborative Professional Learning

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### Introduction

One million teachers educate millions of students within America's rural and remote communities (McFarland et al., 2018). The rural STEM educator is unique in that s/he is likely to experience both geographic and professional isolation (Collins, 1999) as well as a lack of quality pre-service and in-service training (Jerald, 2002; Royster, 1994). A possible solution to address issues of isolation and strengthen pedagogical content knowledge is online teacher professional development (oTPD). However, online learning environments for oTPD have been found to poorly approximate in-person collaboration (Cady & Rearden, 2009). Answering the call from Dede et al. (2009) to investigate questions of community, collaboration, and communication in oTPD, this study seeks to understand the nature of collaboration in a traditional online PD environment supplemented with a tangible user interface for mathematical modeling.

### Conceptual Framework

Sense-Making  
McCarthy and Wright (2004)

Anticipating  
Connecting  
Interpreting  
Reflecting  
Appropriating  
Accounting

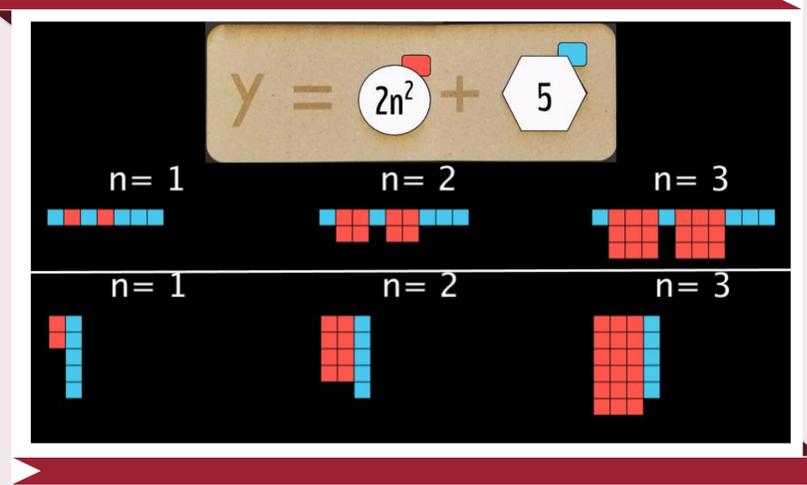
High-Quality PD  
Desimone (2009)

Content Focus  
Active Learning  
Coherence  
Duration  
Collaborative\*  
Participation

Collaboration via  
Representation  
Suthers (2003)

Initiating  
Investigations  
Facilitating  
Deixis  
Group Memory

\* Desimone's (2009) 'collective participation' is reframed to collaborative participation by van Driel, Meirink, van Veen, Zwart (2012).



### Research Questions

What is the nature of collaboration between participants in a synchronous online professional development environment supported by distal tangible mathematical modeling?

- How are participants interacting and collaborating through the tangible interface?
- How are participants making sense of the mathematics within the tangible professional development environment?
- What is the relationship between the collaborative work that is happening within the traditional online PD environment and that within the tangible modeling environment?

### Methods

Twelve volunteer rural secondary mathematics educators will participate in a content-based online PD. Participants will be paired and synchronously work through the online PD. Each participant will have a computer that hosts the traditional online PD environment, including video-conference, and a second computer supporting the tangible user interface (TUI)/augmented reality system. Participants will have sets of manipulatives to use in order to jointly model mathematics within the TUI. The TUI will capture screen recordings of the participants' use of the interface. Further, audiovisual recordings of both the traditional PD environment and the physical TUI use will be captured. Transcripts of both semi-structured participant interviews and the communication within the video-conferencing environment will be coded using a priori and emergent codes (Glaser & Strauss, 1967). Screen recordings and audiovisual data from the TUI will be coded using a priori codes from Suthers and Hundhausen (2003) concerning the ways in which representation is used toward collaborative problem solving. Desimone's (2009) five characteristics of high-quality PD will also be used to code video data taken from the duration of the professional development. Finally, video captured from the traditional and TUI will be analyzed for mathematical work using McCarthy and Wright's (2004) six processes of sense-making.

### Anticipated Findings and Contributions

Anticipated findings include a difference in the nature of collaboration through mathematical representation between the traditional and tangible environments within the professional development. Further, results are likely to indicate that online teacher professional development interfaces supplemented by tangible user interfaces for content modeling have the ability to satisfy Desimone's (2009) framework for high-quality PD, with specific further exploration of 'content-based' sense-making, 'active learning,' and 'collaboration' possibilities within oTPD. Contributions to the field include an answer to Dede, Whitehouse, and Whitehouse (2010) and McCloskey's (2009) call for innovative online collaborative PD and data collection through the use of emerging technologies, specifically for distal participants. Results from this study may have potential implications for the design of virtual PD environments and online PD programs. In addition, the study adds to the body of literature concerning the analysis of collaboration in online spaces. Implications for distal learning and distal professional development are also anticipated.

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