CREATIVE MATHEMATICAL REASONING AND CONTENT AS AN EVALUATIVE FRAMEWORK FOR PRESERVICE TEACHER EXPERIENCES

Tami S. Martin
Illinois State University
tsmartin@ilstu.edu

Craig J. Cullen
Illinois State University
cjculle@ilstu.edu

Our research focused on developing a profound understanding of fundamental mathematics (PUFM; Ma, 1999) for Preservice Secondary Mathematics Teachers (PSTs). We considered content and reasoning ability. Our research questions were: (a) To what extent does working on a quadratic exploration task engage preservice secondary mathematics students in components of creative mathematical reasoning (CMR; Lithner, 2008)? (b) Which mathematics concepts do preservice secondary mathematics students draw upon while engaged in the task?

Theoretical Perspectives

We used Lithner's (2008) classification of CMR and imitative reasoning (IR) to describe student reasoning. CMR includes a *novel* reasoning sequence, makes use of *plausible* strategies, and has a *mathematical foundation*. Lithner described IR as the "opposite" (p. 256) of CMR.

Methods

In a mathematics content course for third- and fourth-year PSTs focused on the roles of technology in the teaching and learning of mathematics (Cullen, Hertel, & Nickels, 2020), we asked students to explore the effects on the path of the vertex as each parameter in the quadratic standard form, $y = ax^2 + bx + c$, was varied. We video recorded class sessions, coded for CMR and IR (Lithner, 2008), and identification of secondary mathematics curricular concepts.

Results

Throughout the exploration we identified students engaged in CMR with concepts from secondary mathematics. For example, Jared reasoned about the concept of slope and linearity while reasoning about the path traced by the vertex as b was varied. Jared's reasoning was *novel* because he asked himself why the path was linear. Jared's strategy—to purposefully adjust parameter sliders, one at a time—was *plausible* because it allowed him to draw conclusions about the effects of those parameters. Jared's conclusion that the slope depended on b was based on a *mathematical foundation* of what is meant by dependent. Thus, we concluded that Jared's reasoning was an example of CMR that involved consideration of secondary-level mathematical content (e.g., linearity, quadratics, rate of change, loci of points) at a profound level.

Discussion and Conclusions

As we reflect on our PSTs' engagement with the Exploring Quadratics task (Cullen, Hertel, & Nickels, 2020), we learned that the task kept PSTs engaged in CMR (Lithner, 2008) throughout the multi-day exploration. Likewise, the content areas which they drew upon were pertinent to their developing subject matter knowledge (Shulman, 1986) and, because concepts were debated in a way that focused on meaning, rather than from an algorithmic approach, the activity seemed to be supporting the development of PSTs' PUFM (Ma, 1999). As a result, we suggest that analyzing tasks for PST populations looking for CMR as well as in-depth engagement with mathematical content linked to future teaching assignments may serve as a framework for identifying appropriate tasks.

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