Scaffolding Preservice Teachers Online: The Roles of Interest and Mathematical Beliefs

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Abstract: Discourse analysis and grounded theory were used to study the responses of 12 preservice teachers (PTs) to scaffolding: 6 received content-informed scaffolding and 6 received performance feedback. PTs receiving content-informed scaffolding varied in the content and form of their scaffolding from PTs receiving performance feedback. Readiness to learn from scaffolding appears to be influenced by interest for mathematics and problem-oriented mathematical beliefs.

Introduction

Preservice teachers (PTs) often have limited knowledge of mathematics and this then impacts their work with mathematics and the way in which they are then prepared to work with their own students (RAND Study Panel, 2002). The Math Forum's *Online Mentoring Guide* (OMG, mathforum.org) was developed to support PTs to learn how to scaffold the mathematical thinking of elementary pupils working with nonroutine challenge problems. Embedded in the task is the need to work with and practice work with mathematical thinking. Studies of the OMG indicate that without mathematical content knowledge, PTs are not in a position to effectively facilitate the development of elementary students' mathematical thinking, nor are they in a position to further develop their own mathematical thinking independently (Renninger, Ray, Luft, & Newton, 2006a). These studies indicated a need for PTs to receive content-informed scaffolding themselves—scaffolding that is based in mathematics and enables the learners to make connections to, develop strategies, self-regulate, and be emotionally supported; findings from this work suggest that PTs can benefit from content-informed scaffolding that helps them to focus on mathematics, and the experience of receiving feedback that is then faded over time (Renninger, Luft, Ray, & Newton, 2006b). Unanswered in this work is the question of how the content and format of content-informed scaffolding differs from the content and format of performance feedback, and how PTs respond to Mentor's suggestions based on these differences. Moreover, consistent with the NRC (2001) suggestion that a key strand in mathematical proficiency is productive disposition, the roles of PT interest and mathematical belief about mathematics were further investigated using discourse analysis (Gee, 1999) and grounded theory (Strauss & Corbin, 1990).

Background on the OMG

The OMG is an asynchronous collaborative tool for supporting PTs to learn how to provide online scaffolding to learners working with nonroutine challenge problems. Lessons in the OMG each include a 4-phase process of doing, reflecting/discussing, interacting with an experienced mentor, and synthesizing the experience of the previous three phases. After completing the lessons in the OMG, PTs in the present study were assigned elementary student submissions (threads) to the Math Forum's Fundamental Problem of the Week (FunPoW) to scaffold. PTs drafted a response to the solution, which was read over by a Mentor who either sends it back to the PT suggesting needed revisions or sends it on to the elementary student.

Methods

Briefly, discourse analytic methods and grounded theory were employed to study the work of 12 PTs, 6 of whom received content-informed scaffolding and 6 of whom received performance feedback, 3 in each group were identified as having more-developed interest and 3 were identified as having less-developed interest for mathematics. All exchanges between the Mentors and the PTs were archived. Analyses of these data addressed: (a) whether PTs were more likely to make effective use of mentor suggestions if they were content-informed, and (b) the role of PT interest and mathematical beliefs on readiness to work with mentor scaffolding. Analyses addressed both content and form (see Fig. 1).

PT Response:

Hello Student 1!

Thank you for submitting your solution to this problem. You did a good job mathematically

applying your strategy and finding the correct solution. Congrats!
There are only a few minor suggestions I could make to improve your solution's clarity.
I really enjoyed how clear your chart was, but there are some units missing. You remembered to label the total "miles" on the walking section of the chart, but there are no similar units for the miles that Zach rode the horse. Also, make sure you leave a space when writing fractions otherwise, 3 and 1/2 looks like 31/2.
Always try to reflect on your work and check it for accuracy. I look forward to reading your revision.
~PT 1

Coded Mentor Feedback:
The biggest suggestion I have is that instead of asking the student to give a reflection, try to encourage them to do so with questions.
Sometimes I ask questions like: Was this problem hard or easy for you? Why? Did you do anything to double-check your answer was correct? Did this answer surprise you? Did you think it would take longer or shorter to walk and ride 50 miles?
(*Content: *Model Reflection [Math Pedagogy]* Form: *Telling, Specific, No Explanation)

PT's Revision [due to space, only additions are noted]
Also, I liked that you added your mileage from both walking and riding together to see how many miles Zachary had traveled. What made you decide to do this? Could you explain this process to me and how it relates to the total miles Zach had to travel?
Now that you've done such a good job in answering the problem and explaining your solution, could you show me how you checked your answer to make sure it was right? What did you think of this problem? What was the hardest part? What made you decide to use your graph to help you explain?
(PT* UNDERSTOOD *Mentor's suggestion to Model Reflection. Evidence: Added own examples of reflective questions)

Figure 1. Sample, Coded PT and Mentor Exchange

Results

How do the content and format of content-informed scaffolding differ from the content and format of performance feedback, and how do PTs respond to suggestions based on these differences?

PTs who received content-informed scaffolding had different patterns of response to their Mentor's suggestions than those who received performance feedback. Findings indicate that:

a) Mentors using content-informed scaffolding, encouraged PTs to:
   - focus more on mathematics and math-specific pedagogy than mentors giving performance feedback, and mentors giving content-informed scaffolding were more varied in the content of the feedback they gave.
   - vary the types of sentences they use, mixing statements, open-ended, and leading questions.
   - focus on whether and how the elementary student was evidencing mathematical thinking to generate questions that would model reflection and encourage the elementary student to reflect in the process of answering questions.

   Mentors using performance feedback were likely to lead PTs to:
   - tell the elementary students what to do, and did not encourage PTs to ask leading questions.
   - led PTs to use only statements.
   - led PTs to comment on the inadequacies of elementary student work, suggesting that the students were cheating or not doing their work.
   - told elementary student to reflect without providing a model.

b) How did the PTs respond to the different forms of mentoring?
   PTs in both groups were predominantly told what to do and were likely to parrot the suggestions of the Mentor. However, PTs receiving content-informed feedback were also likely to understand what they were told to do and were able to rephrase the Mentor's suggestions as their own words when responding to the elementary students, whereas the PTs who received performance feedback were not. PTs who received

content-informed feedback responded differently to being told what to do and receiving information about what to do in the form of a question. They were less likely to parrot the information provided by the Mentor, but they also were more likely to make mistakes.

What is the impact of PTs' interest and problem-oriented mathematical beliefs on their readiness to work with scaffolded feedback?

PTs' readiness to learn from content-informed scaffolding was mediated by both their interest for mathematics and their problem-oriented mathematical beliefs. Interestingly, however, while some PTs had higher interest for math and were more likely to be problem-oriented in their mathematical beliefs, interest and belief were not correlated. PTs abilities to work with Mentor feedback appears to be impacted by interest and mathematical beliefs. Together with content-informed scaffolding, PTs who had interest and/or problem-oriented mathematical beliefs supported PTs to work with Mentor suggestions. Problem-oriented mathematical beliefs also appeared to support PTs to work with performance feedback.

Discussion

Content-informed scaffolding is scaffolding that encourages reflection, identifies and stretches a learner's thinking, and considers the content of the mentoring to be mathematical problem solving rather than the problem at hand. Mentors who provided performance feedback, in contrast, gave task specific directions in one of two ways. They either told students this is an area of weakness: fix it, or they told students you can make your performance better in this area by doing the following (e.g., reflect). Regardless of the type of mentoring PTs received, PTs were inclined to provide performance feedback to the elementary students. As evidence from prior study suggests, because the PTs' classroom feedback was performance feedback, the PTs did not have a model or a vision of content-informed scaffolding other than that provided by the online Mentors and the few examples in the OMG. This discrepancy may account for what appears to be the likelihood of PTs' ignoring or misunderstanding suggestions that were content-informed scaffolding. However, three trends emerge from these data suggesting the the possibility that PTs such as these can be supported through content-informed scaffolding to provide content-informed scaffolding: First, PTs in the content-informed scaffolding group demonstrated understanding of Mentor suggestions regardless of interest or problem-oriented mathematical beliefs more frequently than those in the performance-feedback group. Second, among PTs receiving content-informed scaffolding, higher interest PTs were more likely to make use of Mentor suggestions than lower interest PTs. Third, all PTs with problem-oriented mathematical beliefs were more likely to make use of Mentor suggestions than those with accuracy-oriented mathematical beliefs. It appears that productive disposition conceptualized as including interest and problem-oriented mathematical beliefs do impact readiness for scaffolding.

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