EXPLORING PROSPECTIVE TEACHERS' WRITTEN FEEDBACK ON MATHEMATICS TASKS

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This cross-case analysis of three distinct letter writing activities between prospective teachers (PTs) and K-12 learners provides insights into PTs' levels of feedback according to Hattie and Timperley's (2007) framework. PTs' written feedback from letter writing activities conducted in teacher preparation programs were analyzed using this framework in order to describe feedback provided to K-12 learners by PTs. Crossing the borders of programs at three different U. S. universities, elementary and secondary teacher preparation, and elementary, middle, and high school learners, evidence indicates that PTs provided feedback focused on self, task, and process but rarely on self-regulation. Further, they did not adequately address incorrect answers and redirected student thinking as often as building on student thinking. Recommendations for teacher preparation activities that address the development of feedback practices are provided.

Keywords: Teacher Education-Preservice, Instructional Activities and Practices

Purpose for the Study

Providing feedback positively impacts student learning (Hattie & Timperley, 2007; Shute, 2008; Black & Wiliam, 1998) and mathematics performance (Fyfe, DeCaro, & Rittle-Johnson, 2015). Attention to the development of prospective teachers' (PTs') feedback practices can therefore impact student learning once PTs enter the classroom. Hattie and Timperley's (2007) review of feedback research offers a framework for describing feedback which asserts consideration of the goals, progress, and what is needed to reach the goals are required for feedback to be effective. This framework categorizes feedback as information on the self, process, task, and self-regulation and describes the effectiveness of each type. Considering evidence of the potential impact on student learning when effective feedback is incorporated, we explored the ways in which PTs give feedback. Specifically, what levels of feedback (Hattie & Timperley, 2007) do PTs provide in written comments to students about their performance or mathematics learning? To answer this question we analyzed PTs' written responses to mathematics students about their solutions to mathematics tasks. Findings from the analysis provide insight into levels of feedback given by PTs and suggest activities which develop PTs' handling of incorrect responses, attention to self-regulation, and skills in building on students' mathematical thinking are needed.

Perspective

Black and Wiliam (1998) described written feedback as a formative assessment practice used to move students toward instructional goals and significant in supporting student learning. Many factors (Hattie & Timperley, 2007; Shute, 2008; Wiliam, 2011), including the use of praise (Brophy, 1981), correlate to student learning. The use of feedback to learn is a function of how students attend to and interpret the feedback (Wiliam, 2011). Students' reflections on teachers' feedback illustrate that emotional responses to feedback mediate how the information impacts learning (e.g. Hargreaves, 2013; Havnes, Smith, Dysthe, & Ludvigsen, 2012). These factors illustrate that feedback practices are relational (Fletcher, 1998) and highlight the need to understand PTs' approaches to feedback. We view written feedback as a teaching practice that supports relational interactions between mathematics teachers and students and creates opportunities for student learning in mathematics.

While no studies have examined feedback as a relational practice, meta-analyses have highlighted the effects of feedback (Wiliam, 2011) and defined feedback in various ways: as

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"information communicated to the student that is intended to modify his or her thinking or behavior for the purpose of improving learning" (Shute, 2008, p. 154); or as "information generated within a particular system, for a particular purpose" (Wiliam, 2011, p. 4). Wiliam's (2007) discussion of providing feedback in mathematics identified *comments only* feedback as having the potential to positively impact students' attitudes toward mathematics. Student characteristics were shown to mediate these effects, thereby highlighting the role of the teacher's relationship with the student in the practice of giving feedback. We draw on these definitions to create a relational view of feedback as information generated within an instructional system and communicated to the student with the intention of improving learning or performance.

A logical extension is that the feedback must be taken up by the learner in order to be effective. For this to occur the feedback must be seen as supportive of the student or the feedback likely remains a suggestion rather than a call to action. We find that PTs act relationally in letter writing, working not only to build mathematical performance, but also to show care by drawing on interests of students and their thinking to create feedback. Although efforts may begin haphazardly, Crespo's (2002) work illustrates that these efforts can be supported to encompass attention to the self as well as mathematics involved in the task.

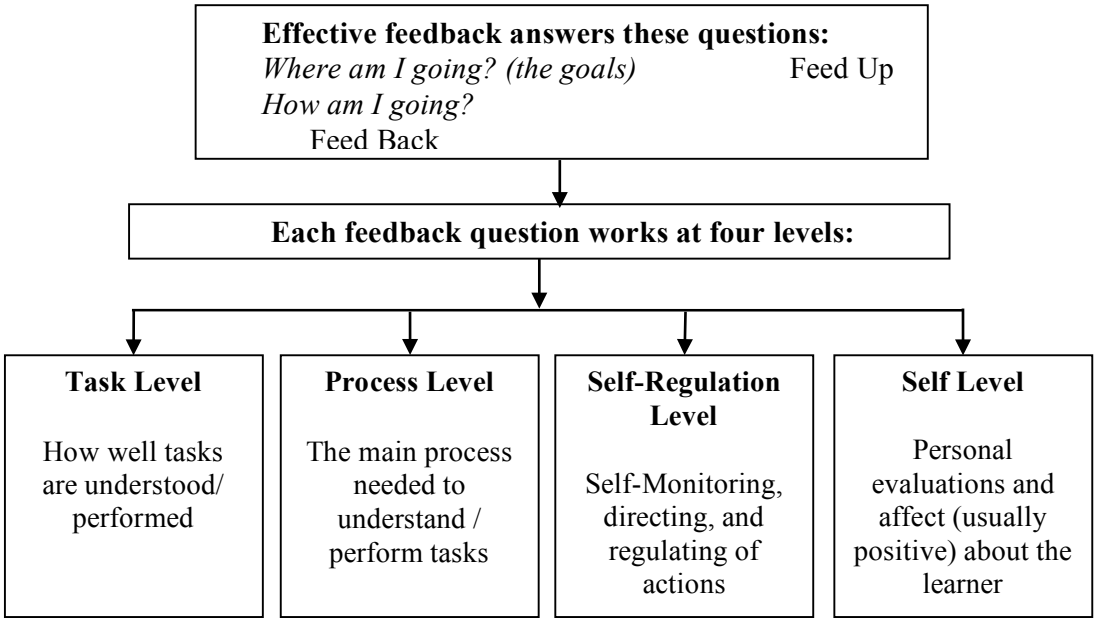

Figure 2. Feedback Model (Hattie & Timperley, 2007, p.87).

Hattie and Timperley's (2007) "model of feedback to support learning" (Figure 1) informs discussions about why "particular kinds of feedback promote learning" while others do not (p. 86). Focusing on PTs' feedback to students about their mathematics task work, we address the question "How am I going?" (p. 89) and use this framework to describe PT's feedback at four levels: task level (FT), process level (FP), self-regulation level (FR), and the self level (FS).

We use these levels to develop a profile of PTs' feedback approaches to answer the question: What levels of feedback do PTs provide in written comments to students about their performance or mathematics learning? Each of the authors independently designed opportunities for PTs to gain insights into students' thinking through letter writing, which we considered an approximation of practice (Grossman et al., 2009). PTs provided written feedback to students about their responses to mathematics tasks in the form of letters. Existing research on letter-writing (e.g. Crespo, 2002) has

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focused on the types of tasks PTs select or create. We instead describe levels of feedback PTs provide in their responses to students' mathematics.

Modes of Inquiry

We analyzed PTs' letters from three university teacher education programs in the US. All three letter writing activities involved PTs providing feedback to students on work from mathematics tasks to support mathematics learning. The contexts are described in Table 1.

Table 1: Descriptors of the Three Letter Writing Contexts

	Context 1	Context 2	Context 3
Setting	• Rural Midwest • Elementary Education • Mathematics methods	• Suburban Southeast • Secondary Education • College Geometry	• Small Midwest City • Elementary Education • Mathematics methods
Participants	• 19 PTs • 19 Fourth grade students	• 12 PTs • 12 Ninth grade students	• 100 PTs • 76 Sixth grade students
Structure of Task	• 5 letters exchanged between PTs/students • One PT paired with one student • Different mathematics tasks were addressed	• 5 letters written by PTs with 4 student responses • One PT paired with one student • One problem situation addressed through all correspondence	• 1 letter written by PTs (draft and final letter) • 1-3 PTs paired with one student • One mathematics task was addressed
	• PTs wrote a self-report focused on difficulties and insights in corresponding with children	• PTs wrote a self-report focused on PTs abilities in eliciting student thinking and their reflections on learning about feedback	• PTs revised letters after having received written feedback provided by the instructor
Data	• Exchanged letters • PT self-reports	• Exchanged letters • PT self-reports	• PTs' letters • Students' work

Similarities cut across the borders that described the three contexts related to settings, participants, structure of the task, and data, and yet each context maintained unique features. This combination of common and unique characteristics across the contexts provided for data analysis and interpretation that considered how these characteristics might allow for similarities and differences in results and, in turn, better inform the development of PTs' feedback practices.

Hattie and Timperley's (2007) four levels of feedback (FT, FP, FR, and FS) were used to code PTs' feedback. Several coding iterations were conducted while the researchers clarified meanings of the levels of feedback in each context and appropriate uses of codes with respective data. In each context, student responses to tasks were used as a data source to clarify ambiguous

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statements in PTs' feedback. For example, a PT reflected, "I praised her on her unique thinking strategies that helped her arrive at the correct answers." Unsure of the PTs' meanings for "praise" and a "unique thinking strategy," we searched the PT's letters for evidence of praise for a thinking strategy. The "unique thinking strategy" referred to specific approaches taken by the student such as the following: "I noticed that you knew that you could the (sic) use multiple units to measure the different items." Referring to other data sources clarified the coding of the use of praise as FS and the "unique thinking strategy" as FT. Data chunks that contained more than one level of feedback were labeled with more than one code. Categories within each level (i.e., non-specific and specific praise within FS in Context 1) were developed for each context. We then compared findings from the three groups of PTs to identify commonalities and differences in levels of feedback given, which will be presented in the cross-case discussion.

Results

Findings from Context 1

A majority of PTs in this context provided feedback in the form of FS or FT, with a few providing FP and none acknowledging FR. Twelve of 19 PTs identified praise or FS as a component of their feedback. One PT suggested she used general praise such as "good job." Two other categories of praise linked FS to FT. Five of the PTs described *non-specific praise* of the student's responses (e.g., "I liked how you answered that question"). PTs who used non-specific praise described preserving self-esteem or motivating the student as a rationale for this approach. The six remaining PTs described using *specific praise* that identified what the child had done well. One PT described this approach "My feedback to my Pen Pal was always very encouraging and included things like, 'I like that you did . . .'." These PTs valued providing task specific feedback with praise and were aware they were being specific about what was valued. For example, "I would make sure to write compliments about what they saw in the graph and then explained why that was good that they saw that." With the exception of the PT providing praise alone, the remaining PTs coupled FS (praise) with FT, such as whether the answer was correct, or FP, focusing on processes involved in mathematics. One PT wrote,

> I even broke down how I thought he was thinking about something, so that it was obvious that we were on the same page, that I liked seeing how he did it, and also to give him an example of how to be descriptive as he thinks and writes about math.

Ten PTs were aware that they were providing FT and explained their approaches. Three PTs identified providing feedback whether answers were correct or incorrect. Remaining statements about FT highlighted the PTs' need to focus on what was correct or the strengths of the student's work such as "I told him what he did well on and if he didn't get something right I would explain it so hopefully he would understand." These PTs described a desire to explain how a student might be able to think about the problem, as in the response above, or to extend the student's thinking by suggesting particular strategies. For example, when a student incorrectly interpreted a graph, the PT "recognized the method he used and then elaborated on his thinking," suggesting that the child "look at what the X and Y sides on the graph represent." Overall, the PTs were conscious of not explicitly stating students' answers were wrong, what some called "negative feedback." Instead, they provided "corrective feedback" (Hattie & Timperley, 2007, p. 91) such as solutions or suggestions, as in the graphing example.

Six PTs provided FP. One PT reflected that he always commented on the child's strategies to "help her become more aware of the different thinking methods that you can use to arrive at an answer." His feedback focused on describing the student's work as general strategies. For example, when the student gave an estimate of a measurement and a result of her measurement, the PT

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described this as estimating before measuring or computing. Remaining PTs focused on "motivating" students to write more about their thinking or the numbers they choose: "I prompted her to be more specific and write about the specific numbers that she sees." PTs' focus on eliciting detail was motivated by a need to understand the child's mathematics. They shared: "I asked how he was seeing the math. The hope was that it was clear to the student that I wanted him to be detailed and descriptive so that I understood how he was seeing it." PTs' reflections suggest they provided FP to gain evidence of student thinking rather than to support the child's thinking. The PTs' need for more evidence resulted in feedback on students' processes.

Findings from Context 2

Data in the second context revealed that PTs provided feedback in the areas of FS, FT, and FP but that they did not provide FR. Thirty-seven instances of praise (FS), often addressing student's effort, were identified in the letters. Eighteen instances were non-specific statements about self (e.g., "I appreciate your hard work so far. You are making great progress."). And 19 instances included specific statements about the process (e.g., "I really like the way you used your knowledge about the angle measures of a triangle to find all three angle measures.").

PTs' FT (55 instances) attended to two particular areas: helping students draw a picture of the problem situation, and addressing a particular concept need to solve the problem. This letter writing exchange required students to draw a model to construct a solution. PTs attended to the difficulties students had drawing the model. For example, a PT wrote:

> The pirates are facing each other in the locations the problem gives. One last thing, be sure to pay attention to any geographical locations that are given. You can use the compass at the bottom of the map to help. I have highlighted these things for you!

After addressing the model, PTs made efforts to move students toward ideas that focused on concepts that would aid in solving the problem. For example, another PT wrote:

> You are correct that angles do not have the same measure. You are also correct that you know the two angle measures, but let's think about AA for a minute. You said that it was a congruence postulate, but if I had two triangles as shown below with the given angles they do not appear to be congruent triangles. Why is that? AA is a postulate, but it is not a congruence postulate. Keep working you are almost there.

In the area of FP (47 instances), PTs tended to give feedback that either used student statements as the basis for further questions (*building on*) or acknowledged the student statements and then asked a question that was not directly related (*redirecting*). For example, one PT suggested a direction the student should pursue, building on from the student's statements: "In your last letter, it looks like you created a triangle in your map. I like where you were headed with that. Perhaps that is what you should be looking for moving forward." In contrast, another PT redirected the student:

> What you did was draw two parallel lines, but why do you need them? Are we able to get rid of them and still work the problem? With getting rid of the parallel lines . . . we can now connect point A and point B, since that is where the two pirates are.

Findings from Context 3

Feedback written by PTs in Context 3 addressed FS (93 instances), FT (140 instances), FP (90 instances), and FR (7 instances). Much of the PTs' feedback included some form of praise (FS) and was more often than not connected to FT or FP. Praise related to the task addressed correct answers, such as "4/6 is a correct answer! Very good." Praise related to the process addressed strategies used by students: "Your strategy … is a smart way to approach this problem." PTs also acknowledged students' responses without specific use of praise, such as "I can see that you understood what each

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fraction is." Two feedback responses included praise focused on FR such as "It was good to see that you tried a different approach at first, and when it did not work you were able to adapt your approach."

PTs provided feedback on the task (FT) that identified correct or incorrect answers (e.g., "Your answer is correct!" and "You are thinking of numbers between the 2 fractions, but 4/5 is actually bigger than 5/8 & 3/4"), and also identified when students did not provide an answer (e.g., "Unfortunately, I am unable to find your answer. What fraction falls between 10/16 and 12/16?"). Additionally, PTs encouraged students to consider more than one answer (e.g., "… could you find another answer that would fit? Or, is 11/16 the only possible answer?").

Feedback on process (FP) requested more information from students, or made suggestions to provide direction for students. A PT wrote, "… could you explain this pattern to me?" Other PTs suggested students visualize relationships among fractions by drawing shaded regions, or number lines. One student had a list of 5/8, 6/8, 7/8, 8/8, 3/4, 4/4 with no explanation, and the PT wrote:

> … start by showing the two fractions as pies so that you can see how they compare. Split the pies into parts to show 5 parts out of 8 and 3 parts out of four. To find one fraction how could you make two pies of the same size using fractions that are still equal to 5/8 and 3/4?

PTs provided FP that clarified faulty procedures in students' attempts to solve the task (e.g., "However, not all numbers between the numerators and the denominators will be between 5/8 and 3/4. For example, 7 is between 4 and 8 for the denominator, but 4/7 is not between 5/8 and 3/4."). PTs also provided suggestions to build on students' strategies. For example:

> Your number line shows us the fourths and eighths for a denominator. However, you can use this number line to show even more possible answers by including sixteenths (1/16, 2/16, 3/16 and so on) and twenty-fourths (1/24, 2/24, 3/24, and so on).

Sometimes (33 instances) PTs' feedback on process (FP) redirected students to strategies not related to the students' work:

> Although there is a pattern of numbers between numerators and denominators, . . . I would suggest to you to find what the decimals are of both fractions, and then try to make up different fractions that would give you a decimal in between both of those two numbers.

PTs were prompted to provide specific feedback to students. The findings illustrate that PTs attended to instructions with providing specific FT and FP. While FT attended to correctness and progress on completing the task, the FP requested more information from students to explain their thinking, suggested a direction that built on students' solutions, or redirected students to a different approach to the task.

Cross-Case Findings

Looking across the contexts we can answer the question: What levels of feedback do PTs provide in written comments to students about their performance or mathematics learning? Across the contexts PTs provided FS, FT, and FP, with a few instances of FR in Context 3.

Praise (FS) was present in the data from all the contexts with differences in the way it was used. The majority of the PTs in Contexts 1 and 3 provided praise either in relation to the task or to the process. In Context 1, PTs were aware of their use of praise, highlighting it as part of the design of feedback. In Context 2, praise of effort was common. We hypothesize that these differences in the use of praise are the result of the activity contexts. In Context 2, PTs were writing to high school students whose answers were generally incorrect. For those PTs, effort was the only element of the response warranting praise. Secondary PTs' attention to effort in feedback is consistent with the findings of Norton and Kastberg (2012). We hypothesize that secondary PTs might attend to effort in

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constructing responses to problem solving situations because of their awareness of the role of effort in successful problem solving. In contrast, PTs in Contexts 1 and 3 may not have viewed problem situations as requiring sustained effort.

PTs in elementary programs may initially share general praise as shown in Crespo's (2002) findings, but for PTs in Contexts 1 and 3, praise tended to be associated with either FT or FP. Some PTs in Context 1 praised correct answers in non-specific ways. Other PTs, including those in Context 3, tended to combine praise with specific FT or FP on student responses.

While studies of teacher praise suggest that it is not useful to students, PTs may be using praise in letter writing to communicate care. Unlike oral praise that is meant to reinforce behavioral aims (Brophy, 1981), PTs identify praise as a way to demonstrate care and support effort. Particularly where PTs are unfamiliar with the students or the academic goals of the students' teachers, their feedback seeks to reach out to the students to make a connection and then to attend to feedback on the task and, in some cases, processes involved in completing the task. This finding is consistent with emerging use of reform practices across letters Crespo (2002) identified in PTs' teacherly talk.

PTs in all three contexts provided FT. Attention was paid to the student's correctness, and as in Crespo (2002), PTs were explicit when students provided correct answers, but not when answers were incorrect. Instead, PTs focused on task specific approaches or concepts that could lead to correct answers. In Study 2, PTs suggested ways in which students could create a model to support their reasoning. In all three contexts PTs provided specific examples or suggestions the students might use to solve the problem or move toward a correct answer.

PTs in all three contexts attended to FP; however, significant differences were identified. Some PTs in Contexts 1 and 3 requested further evidence from students with those in Context 1 suggesting that further evidence was needed to gain insight into student reasoning. PTs in Contexts 2 and 3 providing FP suggested processes that drew from PTs' inferences about processes students were using. This feedback was described as *building on*. Other PTs suggested processes that were not aligned with student work. This FP *redirected* students to use a new process, perhaps one preferred by the PT.

Discussion

Research shows that practicing teachers tend to give feedback that is limited to correct or incorrect responses, limiting the educative impact that productive feedback practices can afford (Crooks, 1988). Preparation of PTs in the area of effective feedback practices, based upon their current understandings, can positively impact their ability to make use of this instructional tool. Across the three contexts we see FS, FT, and FP. Some of these uses of feedback are identified as effective (Hattie & Timperley, 2007; Wiliam, 2007) and others are not. To build experience with and insight into the use of written feedback, PTs need opportunities to craft such feedback. Our analysis illuminates the PTs' attention to giving feedback as a relational practice. Attention to students as people whom the teachers did not know may have motivated them to praise the children to build relationships. PTs in Context 1 were aware they were using praise but identified it as motivating persistence and emphasizing the child as a unique person. FT focused on explicit attention to correct responses without the same explicit discussion of incorrect responses. Support for extending or repairing solutions in the form of suggestions or explanations of what to do in the context of the task were provided in FT, yet without explicit attention to incorrect responses students may be confused about the feedback and disregard it (Hattie & Timperley, 2007). FP tended to acknowledge the process used by the student, but was as likely as not to redirect the student to follow a process not related to his or her work.

With these findings in mind, mathematics teacher educators designing instructional activities for the development of feedback practices should be focused on discussions of the role of praise in the instructional system, handling of incorrect and incomplete responses, and building on to student

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processes. PTs have ideas about how to give feedback on the self, task, and processes that can launch discussions of the benefits and drawbacks of various levels of feedback. After initial feedback to student work is crafted by PTs, mathematics teacher educators can discuss the affordances and limitations of various feedback responses in light of professional guidelines (e.g. Wiliam, 2007). In addition, inattention to FR in all but a few responses across the contexts suggests that instructional activities should be developed that attend to self-regulation as a factor in student performance and how to provide feedback on self-regulation. Crossing the borders of our own programs and contexts allowed us to think more deeply about the development of feedback practices of prospective teachers.

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