Examining Prospective Secondary Teachers' Curriculum Use and Implications for Professional Preparation

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In this paper, we share findings around four prospective secondary mathematics teachers' attention to varying curricula while planning an algebra lesson. We specifically address how their attention interacted with their interpretations of and responses to the curriculum materials via idea sequences, and further we study how the format of the curriculum materials plays a role in influencing these interactions. We discuss the result that sequences of interpretations and responses are always initiated by attention for PSTs, which itself is influenced by curriculum elements and format. We end with a discussion of implications around the need for curriculum use practices in teacher education and professional development.

Keywords: Curriculum, Graduate Teaching Assistant, Professional Development, Prospective Secondary Teachers, Teacher Training

Research shows that historically, written curriculum materials play a large part in a teacher's lesson planning. However, the literature suggests that teachers are not prepared to learn to use curriculum materials in adaptive and flexible ways (Drake, Land, & Tyminski, 2014). Since 80% of practicing teachers use some form of curriculum materials in their instruction (Banilower, et al., 2013), teacher educators need to support prospective teachers in learning to use materials. While research indicates that curriculum materials have the most direct influence on what teachers actually plan for and enact in their classroom (Brown & Edelson, 2003) and influence what students have opportunities to learn (Matsumura et al., 2006), we still know little about *how* curriculum materials exert this influence (Stein, Remillard, & Smith, 2007). This paper focuses on how prospective secondary teachers (PSTs) interact with curriculum materials by examining their *curricular noticing,* or what they attend to in curriculum materials, how they interpret what they attend to, and how they respond to the curriculum materials. Specifically, we describe how curricular interpretations and responses relate to curricular attention.

Theoretical Background

Throughout the past few decades, efforts have been made to develop research-based descriptions or models for how teachers use curriculum materials (Lloyd, Cai, & Tarr, 2017). And despite varying descriptions of this use (e.g. Brown & Edelson, 2003; Brown, 2009; Choppin, 2009, Geuedet & Trouche, 2009; Pepin, Geuedet, & Trouche, 2013; Remillard & Bryans, 2004; Sherin & Drake, 2009), each of these descriptions share the perspective that curriculum use involves some kind of interaction between teachers and materials. For instance, this interaction is described as participatory by Remillard (2005), where influence is bi-directional, meaning that the teacher influences the material and the material influences the teacher. Similarly, Geuedet and Trouche (2009) suggest that teachers engage with materials in "documentational genesis." They establish that documentational genesis involves two processes: instrumentation, the process by which curriculum materials influence what and how teachers use resources in the design and enactment of instruction, and instrumentalization, the process by which curriculum materials are influenced by the teacher.

Examining Curriculum Use via Curricular Noticing

We draw on the theory that teachers' interactions with resources are participatory (Remillard, 2005) and use the Curricular Noticing Framework (Dietiker, Males, Amador, & Ernest, 2018) to describe this interaction. This framework was informed by the work in the professional noticing of children's mathematical thinking (Jacobs, Lamb, & Philipp, 2010). Curricular noticing refers to "the set of skills that constitutes the curricular work of mathematics teaching" (Dietiker et al., 2018, p. 524) and is comprised of three interrelated skills: *Curricular Attending, Curricular Interpreting*, and *Curricular Responding*. Curricular attending involves looking at information in curriculum materials to draw upon for the teaching and learning of mathematics, curricular interpreting involves making sense of what is attended to, and curricular responding involves making curricular decisions based on interpretations made. We visualize curricular noticing with Figure 1.

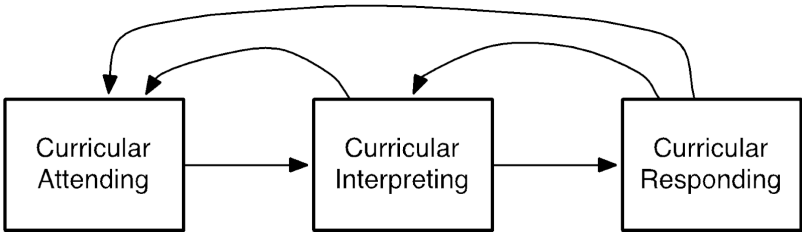

Figure 1. The curricular noticing framework (Dietiker et al., 2018).

While these definitions seem to imply a sequence, Dietiker et al. (2018) propose that this process may not unfold in a strictly linear fashion. For example, while a response relies on a curricular interpretation of something attended to, an interpretation may trigger a teachers' attention, or a particular response may result in attention.

Purpose and Research Questions

The main purpose of this paper is to describe how PSTs interact with curriculum materials, with a focus on the relationship between interpretations and responses and what teachers attend to, and how the curriculum materials influence attention. Specifically, we address the following research questions:

1. How do PSTs' curricular interpretations and curricular responses interact with their attention to the curriculum materials?
2. How do curriculum elements and format of each set of curriculum materials influence PSTs' attention?

By curriculum elements, we mean distinguishable parts of the curriculum materials such as sentences, phrases, representations, and images. We intentionally selected 'element' rather than 'feature' since features often include multiple sentences or paragraphs in curriculum materials. This allows us to describe the skills of curricular noticing piece-by-piece rather than by broad sections. The format that we refer to means the way elements are organized and how the curriculum appears. This includes not only color and location of student and teacher materials, but also 'embeddedness' of teacher supports (Beyer, Delgado, Davis, & Krajcik, 2009). A resource with embedded supports integrates teacher support within the directions and content for enacting activities found in the student version of the resource. Curriculum materials of this category often present teacher materials and student materials on separate pages. On the other hand, we see non-embedded supports in resources that have teacher support close to, but separate, from portions intended for students. Often this occurs on the same page.

Methodology

Participants and Data Collection

Our participants were four secondary mathematics PSTs who had not yet taken any mathematics teaching methods courses, but had completed much of the mathematics required for their degree. We engaged each participant in two semi-structured think-aloud Staged Planning Interviews, a popular style of interview to gain insight into teachers' use of curriculum materials (Males, et al., 2016; McDuffie, 2015; Reinke & Hoe, 2011). In one interview, teachers were asked to plan a hypothetical lesson using as a resource College Preparatory Mathematics (CPM) Algebra Core Connections (Dietiker, et al., 2014), and in another interview teachers were asked to plan using as a resource Pearson Education, Inc. (PEI) Algebra I Common Core (Charles, et al., 2015). We alternated which resource a teacher planned with first, meaning two PSTs planned a hypothetical lesson using CPM as a resource first, while the other two PSTs planned using PEI as a resource first. The two interviews for each participant were conducted at least a week apart.

Data Analysis

Documents and videos from the staged planning interviews were uploaded to a shared drive, and the glasses recordings and images of the curriculum pages were imported into Tobii Pro Labs (Tobii Technology, Inc., n.d.). Lastly, the glasses recordings and transcripts were imported into a qualitative analysis software program. In order to address attention, we used Tobii Pro Labs to map the gaze data recorded by the glasses to each of the curriculum pages. This data was in turn used to create timelines which illustrate when PSTs were attending to student and teacher materials (i.e., looking anywhere on the student or teacher portions of pages) and when they were not attending to the curriculum materials at all (i.e., looking at their written lesson plan, the interviewer, or other places in the room).

To address the interactions of interpretations and responses with attention, we coded the PSTs' transcripts. We assigned an *Interpret* code when a PST engaged in sense-making and a *Respond* code when PSTs made a curricular decision related to what to include (or not include) in their lesson plans. Once coding was complete, we studied PSTs' thought processes via idea units. We define an idea unit as a period of time within the transcript during which a PST focused on one big idea. Within these idea units, we identified idea sequences by recording the sequence of curricular attention, interpretations, and responses. For example, when Fay discusses her thoughts around the problems following the introductory problem in the PEI lesson, we generated the idea sequence in Figure 2.

Figure 2. An example of an idea sequence.

Results & Discussion

Figure 3 illustrates each PST's attention to the curriculum materials for CPM and PEI across the planning sessions. The black portions indicate times when the PST was not attending to the curriculum materials (e.g., looking at their lesson plan or other things in the room) whereas blue and yellow indicate attention to the student and teacher materials, respectively.

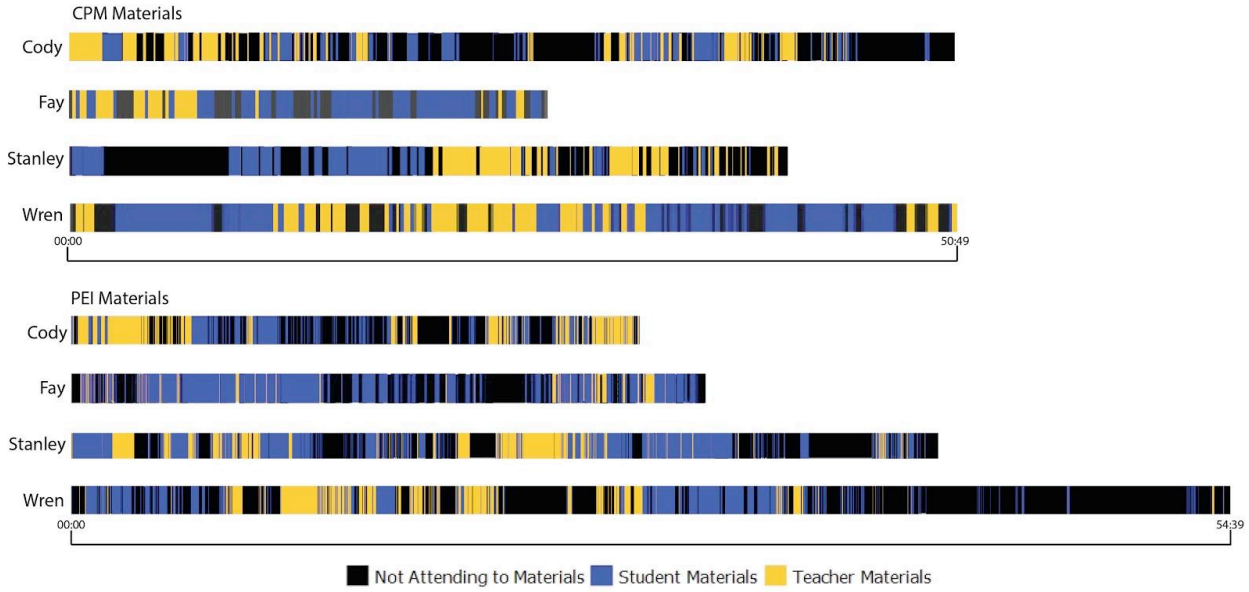

Figure 3. Attention across the planning session by curriculum and PST.

The timelines show that PSTs were shifting frequently between attending to student and teacher materials, with 40-85% of their attention time for both sets of materials devoted to student materials. When planning with both sets of materials, three PSTs spent more time attending to student rather than teacher materials. Cody was the opposite, spending more time attending to the teacher materials in both planning sessions. Looking across the curriculum materials, the timelines illustrate that PSTs shifted between teacher and student more frequently for PEI and that they attended for shorter amounts of time before switching compared to CPM.

While attending (blue and yellow in the figure), PSTs were simultaneously interpreting and responding to the curriculum materials. For instance, for three of the four PSTs, we see heavy concentrations of attention in the beginning of the CPM planning periods. Our idea sequences indicate PSTs were attempting to make sense of the unfamiliar format and content of the materials, often looking back at preceding portions of the text and spending considerable amounts of time interpreting. For example, during this time, PSTs were interpreting the reason for what seems to be provided answers in the student portion of the materials, such as Grant who states "I'm assuming that this…they ask me to write an equation at the top that represents the table below. But then they give me the equation?" Over the course of two and a half minutes, he comes to the realization that the bolded answers are not included in the materials given to the student. The unfamiliar content also seemed to necessitate more attention and interpretation. For example, Cody, who spent 22 more minutes planning his CPM lesson than his PEI lesson, struggled to make sense of the lesson content, specifically what was meant by a tile pattern. At the beginning of his planning sessions, he spent more time searching for information from the teacher materials (yellow in his timeline) and working out his ideas on his scratch paper (black in his timeline) as seen in Figure 4.

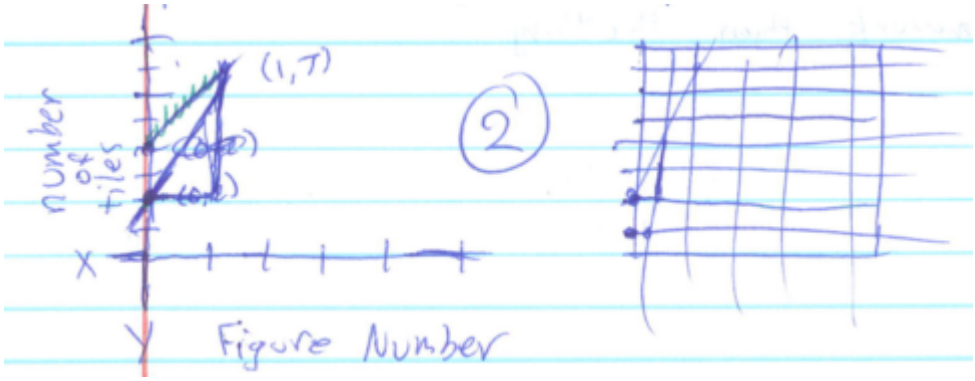

Figure 4. An excerpt from Cody's scratch paper.

Cody first thought that tiles meant a grid of some sort. Then he drew what appears to the left in the figure followed by what appears to the right as he said "So they want to look at tiles… something like that…I see they're trying to bring in some physical type of thing… but to me a normal grid just kind of makes more sense so I'd probably just keep going with the *x*-*y* axis."

Towards the end of the CPM planning periods, PSTs went back to portions they had initially attended to, attending again and then interpreting the intended trajectory or concept before responding based on the alignment of the perceived structure with their own beliefs on how a lesson on slope should be carried out.

In contrast, during PEI planning, we see heavy concentrations of attention throughout the entire planning period for each PST. Examining the idea sequences, we see that many more responses are made, along with interpretations, in the beginning half of these periods as compared to PSTs planning with CPM where responses were made towards the end of the planning periods. The most common interpretations involved PSTs making sense of the introductory slope problem and deciding quickly to adapt or supplement this because it was not "real-world" enough or approached in the way they would like, such as Stanley who says

> …But that's not how I would actually solve that problem in the real world. Because really you just want to take 1 over 0.25, equals 4. 4 over 1 equals 4. 7 over 1.75 equals 4. Use those comparisons. I know these are mathematically equivalent, but this is just a little more roundabout and confusing.

Our idea sequences indicated that PSTs began to work with new ideas by attending, meaning each of our idea sequences began with an Attend code. We also saw that, particularly for CPM, that attending to one curriculum element often led to attention (or repeated attention) to other elements. For example, after reading briefly through the CPM teacher materials around problem 2-12, when attending to the student materials Cody interprets problem 2-12 saying it "seems kind of obvious." He then initially responds by deciding not to use the problem in his plan. However, he goes back to the teacher materials and attends to the suggestions for problem 2-13 and notices that the problems are linked, with 2-12 providing valuable experience, so he decides to use both problems.

Our analysis indicated that idea sequences were different across materials. The average duration of the sequences was longer when PSTs were planning with CPM. In addition, when planning with CPM, in the first half of their planning period, PSTs had many more idea sequences that only involved Attend and Interpret codes (21 out of 53 idea sequences across all PSTs), while with PEI there were many more Respond codes in the beginning of the planning periods (32 out of 49 idea sequences across all PSTs). This means that PSTs made planning decisions much more quickly in their planning period for PEI than they did for CPM.

Implications for Teacher Education and Curriculum

This study provides insight into how different PSTs approach the same curriculum materials and produce a plan to enact in the classroom. Understanding the process of how PSTs plan using curriculum materials has implications for teacher education programs and curriculum development. First, this study suggests that format largely influences attention. All four PSTs in this study tended to switch back and forth more quickly between student and teacher materials in PEI, the non-embedded curriculum materials, and further made quicker decisions when planning with a resource of this format. These occurrences may result in many teacher suggestions being missed, or at the very least misunderstood. When attention is so short in duration to particular curriculum elements, it may be difficult for teachers, particularly early career teachers who have less experience with curriculum materials, to interpret and respond while planning for instruction. This points to the need for attention optimization in curriculum development.

Further, we see from this study that PSTs require opportunities to learn to use curriculum materials. Since this study showed that PSTs interacted differently with varying curricula, we advocate in the same way as Drake, Land, and Tyminski (2014): PSTs need opportunities to learn to use curriculum materials by interacting with different types. Teacher education also needs to guide PSTs in learning how to read curriculum materials. As this study exemplified, it is a skill to recognize and know what elements of curriculum materials are intended for teachers, and which are intended for students.

Extending study to undergraduate mathematics. Like PSTs, graduate teaching assistants (GTAs) who are teaching undergraduate mathematics courses are also early users of curriculum materials as teachers. More importantly though, GTAs may have even less opportunities to interact with materials before using them with students. Broadly speaking, GTAs have very little teacher education, and yet interact with curriculum while planning lessons on a weekly basis. Optimizing college curriculum materials for attention and engaging GTAs in learning how to enact curriculum is crucial for the success of the program.

Teaching preparation of GTAs first became a point of interest as a result of Speer, Gutman, and Murphy (2005). Speer and her colleagues pointed to K-12 professional development as a source from which to draw upon for GTA professional development, and also listed many directions of research to pursue from there. However, what little research we currently have on the topic largely focuses on case studies or development of GTA training programs. Even fewer studies point out the (often unmet) needs of the GTA population. We see interactions with curriculum materials as one such unmet need.

What little professional development GTAs are provided in graduate school is often the first training they will receive (Deshler et al., 2015), and more often than not, this training is provided simultaneously with the required teaching of courses (Ellis, 2016). For example, mathematics GTAs at the author's home university receive a three-day orientation the week before classes start. Examining curriculum interaction specifically, GTAs receive the opportunity of guided interaction with their department-provided curriculum for just an hour and a half duration out of their three-day orientation. This results in the majority of curriculum interaction occurring during the planning and enacting periods of teaching, a time when familiarity and teaching practices surrounding curriculum should already be developed. Further, this length of orientation time is only provided for first-time instructors of precalculus courses, with a curriculum that is set by the department and expected to be followed. GTAs which go on to teach other courses in subsequent years, then, have little to no training on what to look for in differing curriculum materials or how

to interact with them in beneficial ways. We acknowledge that this curriculum interaction component is not necessarily representative of GTA orientations across the U.S., and so this further emphasizes the need for its integration into GTA training overall as teacher educators work to improve the number and quality of opportunities provided to GTAs in learning to use curricula.

Not only does this study point to the benefits of engaging GTAs in curriculum interaction in professional development, but also to the need to optimize college curriculum materials for attention. Since we saw that PSTs' noticing was driven by attention via the idea sequences, we understand that teachers, especially those with little to no teacher training, will more likely engage with curriculum materials that are designed to capture attention. Without this, PSTs, GTAs, and practicing teachers alike are not supported in their teaching practices and are likely to miss important components of curriculum materials, resulting in unintended effects on student learning.

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