MIDDLE SCHOOL MATHEMATICS TEACHERS' USE OF CCSSM AND CURRICULUM RESOURCES IN PLANNING LESSONS

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As part of a larger study, we report findings on teachers' use of the Common Core State Standards for Mathematics (CCSSM) and teacher resources (TR) that were included with teachers' published curriculum programs. We analyzed 147 lesson planning interviews with 20 middle school teachers to understand how teachers interpreted and enacted the CCSSM while working with their curriculum materials. We investigated teachers' noticing of CCSSM and features of TR in planning lessons. Regardless of curriculum, teachers perceived that the lessons were designed to address the CCSSM. Findings for patterns among curriculum type, teacher orientation, and teachers' noticing are presented. Implications for curricular policy and design are discussed.

Keywords: Curriculum, Curriculum Analysis, Instructional Activities and Practices, Middle School Education.

The purpose of this study was to explore patterns related to teachers' orientations to instruction (Remillard & Bryans, 2004), teachers' uses of district-adopted curriculum programs (i.e., *the designated curriculum* [Remillard & Heck, 2014]), and specific curricular features teachers noticed (Jacobs et al. 2010, 2011) as they used teacher resources to plan lessons (i.e., *the intended curriculum*). These lessons – and the designated curriculum – were ostensibly aligned with the Common Core State Standards for Mathematics (CCSSM) (i.e., *the official curriculum*) (Remillard & Heck, 2014). The CCSSM (CCSSI, 2010) were initially adopted by 45 states plus the District of Columbia, and, despite a rollback in some states, the CCSSM or CCSSM-based standards are still in place in most states. Thus, the CCSSM-adopting states share a relatively common articulation of content and the progression of content across the grades. This provides researchers an opportunity to consider how districts and teachers interpret standards and to understand the role of curriculum materials in the process of enacting those standards.

When asked to compare the CCSSM with prior standards, teachers interpreted the CCSSM as requiring a greater emphasis on problem solving, discovery, communication, and conceptually-driven instruction (Roth McDuffie et al., 2015). Although teachers expressed a relatively strong view of these CCSSM features, prior research on teachers' enactments of similar recommendations in the National Council of Teachers of Mathematics Standards documents (NCTM 1989) showed that even reform-minded teachers did not tend to implement the recommendations beyond superficial features (Coburn et al., 2016; Spillane & Zeuli, 1999).

Framework

Our framework draws on three complementary perspectives: orientations toward teaching and learning mathematics, teachers' professional noticing, and types of curriculum programs. Each perspective is described briefly below (also see Roth McDuffie et al., 2017).

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Orientations toward Teaching and Learning Mathematics

We see teachers as designers as they work with and enact curriculum across a range of classrooms contexts (Brown, 2009; Remillard & Heck, 2014). Productive enactments and adaptations of curriculum materials, desired outcomes of the design process, are responsive to local contexts and involve teachers noticing students' mathematical thinking in relation to curriculum resources (Choppin, 2011). However, most adaptations of high cognitive demand tasks cause the cognitive demand to decline to procedural routines (Stein et al., 1996). Thus, how teachers use materials can limit learning opportunities for students; however, others have pointed as well to curriculum materials as limiting factors (Stein et al., 1996). Thus, *which* curriculum materials are designated for use and *how* teachers enact materials can both affect student learning and achievement (Stein et al., 2007; Tarr et al., 2008). In regard to teachers' use of materials, teachers' orientations toward curriculum materials influence how the materials are enacted (Remillard & Bryans, 2004). Remillard and Bryans describe teachers' *orientation toward curriculum materials* and its relationship to learning as,

> A set of perspectives and dispositions about mathematics, teaching, learning, and curriculum that together influence how a teacher engages and interacts with a particular set of curriculum materials and consequently the curriculum enacted in the classroom and the subsequent opportunities for student and teacher learning. (p. 364)

To classify teachers' orientations, we turned to Munter, Stein, and Smith's (2015) two instructional models of instruction, *dialogic* and *direct*. Munter and colleagues' characterizations of primary instructional patterns in US mathematics classrooms represent a consensus view from a group of expert stakeholders, and they describe nine characteristics associated with each model. *Dialogic instruction* entails teachers providing students with opportunities to: wrestle with big ideas, assert and justify claims, and engage in carefully designed, high cognitive demand tasks (cf., Stein et al. 1996). Teachers engage in practices including orchestrating rich class discussions, introducing representations that can be used repeatedly in different situations, and sequencing activities in ways that position students as autonomous learners (Munter et al., 2015). Dialogic instruction is consistent with visions for effective teaching and learning espoused by NCTM (NCTM, 2014) and seminal research in mathematics education (e.g., NRC, 2005; Stein et al., 2007). Although both dialogic and direct instruction reflect a commitment to students' understanding of mathematics, *direct instruction* aligns with an acquisition approach (Sfard, 1998). Teachers maintain primary intellectual authority (along with the textbook) by: presenting an objective for a lesson, demonstrating how to complete problems, scaffolding students' practice, and evaluating to correct students. To engage students, teachers maintain a brisk pace, invite unison responses, and praise correct responses (Munter et al., 2015).

Given that meaningful and authentic problem solving, sense-making, and explaining and justifying solutions are emphasized in the CCSSM's Standards for Mathematical Practice (MPs), then it seems that the CCSSM align with a dialogic model. Yet, the CCSSM are ambivalent on pedagogical approaches (McCallum, 2012). On one hand, the MPs align with the characteristics and goals of dialogic instruction; on the other hand, due to the major gaps in empirically developed learning trajectories in key middle grade topics (Daro, Mosher, & Corcoran, 2011), the middle grade content standards are based on the logic of the discipline as much as they are framed by developmental and reasoning-focused approaches. Thus, the CCSSM leave room for teachers to attend to, interpret, and enact the content standards and MPs in various ways.

In contextualizing research on teaching in a broader system, we turned to Remillard and Heck's (2014) model describing a system for curriculum policy, design, and enactment, as described above, with a focus on: *official curriculum* (e.g., CCSSM and/or other policy documents); the *designated* *curriculum* (plans and curriculum materials authorized by local educational authorities) and *teacher-intended curriculum* (interpretations and decisions in planning). We considered how teachers used and worked between the CCSSM as an official curriculum and their designated curriculum to develop teacher-intended curriculum.

Teacher Noticing in Teaching and Learning Mathematics

An emerging body of research on mathematics teachers' *noticing* supported us in studying how teachers construct an intended curriculum and then enact curriculum (Jacobs et al., 2010, 2011; Mason, 2011). Although researchers have framed noticing in slightly different ways, a commonality is that noticing involves not only the attention that teachers give to classroom actions and interactions, but also teachers' reflections, reasoning, decisions and actions. Jacobs and colleagues defined *professional noticing of children's mathematics thinking* as consisting of a set of three interrelated skills: attending, interpreting, and deciding how to respond (Jacobs et al., 2010, 2011). Jacobs and colleagues argued that *deciding to respond* should be included as part of noticing because it is linked to the other skills of professional noticing (attending and interpreting) "during teachers' in-the-moment decision making." Jacobs and colleagues (2011) view the three skills of attending, interpreting, and deciding to respond as "inextricably intertwined" (p. 99), and we share this view. In forming our analytical framework to investigate teachers' work with curriculum, we adapted research on teacher noticing (Jacobs et al., 2010, 2011) to include curriculum as an object of noticing. Other researchers independently have begun to use a framing of curricular noticing in studying prospective teachers as they learn to work with curriculum materials (*c.f.,* Males et al., 2015).

Types of Curricular Programs

We conceptualize curricula according to monologic and dialogic communication functions (Wertsch & Toma, 1995). We characterize curriculum programs as *delivery mechanism* (DM), if they are designed from the monologic function, in that the content is developed from the perspective of expert performance, to be delivered to novices. In contrast, *Thinking Device* (TD) curriculum programs emphasize the dialogic function so that the primary goal is to elicit student thinking and to provoke interactions that generate understanding. In previous work for the larger study, the curriculum programs used by the participating teachers were analyzed and classified according to these two types (Choppin et al., 2016). The above perspectives framed the study and served as the foundation for our analytic frameworks, as described in the next section.

Methods

From our larger data set, we purposefully selected 20 teachers using four different curriculum programs, with two TD programs and two DM programs. We applied qualitative methods of analytic induction and constant comparison (Bogdan & Biklen, 2007; Miles, Huberman, & Saldaña, 2014) to identify patterns and themes regarding teachers' use of the CCSSM and the teacher resources (TR) that are provided in teachers' designated curriculum materials in planning lessons. The research questions driving the study were: (1) In planning lessons, what do teachers notice in CCSSM and in TR?; and (2) How do types of curriculum materials and teachers' orientations relate to teachers' noticing during planning?

Data Sources

From our larger project data, we selected four districts with curriculum programs of different types. From these districts, we selected 20 teachers who participated for at least one year, so that we had a representation of each of the middle grades (grades 6 to 8) and teaching experience (from first-year to over 20 years). All participating districts and teachers stated that they were implementing the CCSSM in their instruction. Data sources included 147 interviews: pre- and post-lesson interviews

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that focused on teachers' planning with their designated TR, and interviews as teachers planned a lesson with materials that were different from their designated curriculum (using contrasting resources). We collected data over three academic years from Fall 2012 (start of Year 1) to Spring 2015 (end of Year 3), and districts participated in either two or three years of the project, with three to four interviews conducted each year with each teacher participant (see Table 1). The classification shown for each curriculum is based on prior analysis (Choppin et al., 2016).

Table 1: Teachers, Designated Curricula, and Curriculum Type

District	Teachers (with # of Interviews per Teacher)	Designated Curriculum Program (by Year of Study)	Curriculum Type
Anna	Anderson (6), Cartwright (3), Dietrich (7), Martin (3), Shaw (6)	Digits (Fennell, 2010) (Y2, Y3)	DM
Chester	Allen (9), Granville (6), Menard (7), Pless (11)	Connect Mathematics Project (CMP, Lappan et al., 2014), CMP2 (Y1), CMP3 (Y2,Y3)	TD
Denton	Amedon (4), Blackburn (12), Gagnon (10), Gates (9), Hastings (7), Leonard (12), Sprague (6)	Glencoe (Carter et al., 2013) (Y1, Y2), CMP3 (Y3)	DM (Y1, Y2) TD (Y3)
Sanders	Boris (8), Gryder (6), Pearle (8), Ross (7)	CPM Mathematics (Kysh et al., 2013), (Y2, Y3)	TD

Data Analysis

We analyzed data through iterative cycles (Miles, Huberman, & Saldaña, 2014). Initially, using qualitative data analysis software, we coded data with a set of broad codes related to the larger project. For this study, we focused on data coded as "teacher resources" and "planning." We then ran reports to gather all data with these codes for the 20 teachers. We conducted finer level coding of these reports for instances of: (1) evidence of dialogic or direct orientations, applying Munter et al.'s (2014) nine characteristics; and (2) curricular noticing of the CCSSM (e.g., content standards, mathematical practices) and features of the TR (e.g., lesson structure, suggested questions, example problems, student approaches). We generated analytic memos for the participants to describe patterns and conjectures and compile data associated with these patterns. To examine patterns across participants, we created a matrix with rows for each participant and columns for foci of noticing and orientations, as described in the codes above. Within each cell we recorded findings for each teacher and then examined patterns and differences by curriculum program and by curriculum type.

Results

We categorized teachers into one of four categories based on teachers' designated materials and orientations evidenced in planning (see Table 2). For a few teachers, identifying orientation was not as clear as for most. For example, Pearle predominately demonstrated a dialogic orientation when she explained that she focused on "big problems and not just your memorization or your simple computation, like the math that I grew up [doing]" and on writing to support thinking. However, Pearle planned to introduce new vocabulary by presenting it to students at the beginning of the lesson (a direct orientation). In these cases, we classified based on the predominant orientation, with no more than one characteristic aligning with the other orientation. Teachers' orientations were consistent in planning with both their designated materials and with the contrasting materials provided in the interview. We identified two primary patterns for orientation and type of designated materials: TD materials paired with dialogic orientations and DM materials paired with direct orientations. That is, for 17 of the 20 teachers, their orientations aligned with the design of their

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designated curriculum materials. For the remaining three teachers (who demonstrated a direct orientation and were using TD materials), they had previously used Glencoe (DM) and were in the first year of using CMP3 (TD). Their comments and planning indicated that they noticed ways CMP3 was different from Glencoe, but they continued to remain at the center of the lesson, hold authority for content, and prioritize procedures. For example, Gates stated, "I'm …struggling with [CMP because] kids do not get to the standard algorithm…As I say to [my students], I need you to do 145 divided by 7 and just do it with the old standard [algorithm.]"

Table 2: Teachers Categorized by Orientation and Their Designated Curriculum

District	Thinking Device Materials (TD)	Delivery Mechanism Materials (DM)
Dialogic	Allen, Amedon, Boris, Granville, Gryder, Leonard*, Menard, Pearle, Pless, Sprague* (10 Teachers)	(0 Teachers)
Direct	Gagnon*, Gates*, Hastings* (3 Teachers)	Anderson, Blackburn, Cartwright, Dietrich, Gagnon*, Gates*, Hastings*, Leonard*, Martin, Shaw, Sprague* (11 Teachers)

*Note: Denton teachers changed from Glencoe to CMP during the study. Teachers marked with an * appear in two categories, based on the materials they used that year.

Next, we analyzed patterns for curricular noticing in teachers' planning with their designated TR and with contrasting materials (see Table 3). Within each cell, italicized phrases are the topics of noticing, and text that follows represents the primary and consistent themes for each form of curricular noticing (i.e., how teachers attended, interpreted, and decided to respond) within that category. As much as possible, we incorporated teachers' phrasing and terms to represent the theme (e.g., "big ideas", "key questions", "investigations", "inquiry-based", "talk through", "key steps"). In three of the four categories, teachers interpreted the TR as aligning with CCSSM; however, teachers with a dialogic orientation interpreted DM materials as not addressing the CCSSM. These teachers were planning with contrasting TR (Glencoe), rather than their designated TR (CMP3). Thus, all teachers viewed their designated TR as aligned with CCSSM, and yet their interpretations and decisions with the CCSSM and TR in lesson planning varied, as shown in the other cells.

As an example, Allen (dialogic orientation) evidenced her noticing of *CMP3*'s TR features and planned to provide an initial, informal exposure to ratio as a way to develop understanding:

> [I want students to] understand what the numbers are, what they're there for, what they're being used as.…Do they know [what each part of the ratio refers to]?….I always feel like the [first] investigation, it's really just that informal exposure….I think being able to recognize different types of comparisons, what they might look like, how you might get them, I'm just kind of starting to set the stage for [understanding that] isn't [just one] type of comparison.

In contrast, Gates (direct orientation) noticed *Glencoe's* TR features by focusing on the steps she planned to demonstrate and how students will practice these steps.

> For example, 2+y=3, we all use the strategy of bringing down a railroad track and then doing whatever you do to the side…. So I have a process where I usually have them do a few problems with me,…and if I feel like they're okay, I have them do a few problems with a partner, and then if they're doing well, … I let [students work] independent[ly].

Table 3: Noticing Patterns in Planning with Designated vs. Contrasting Curriculum

Teacher Orientation	Curriculum Type	
	Thinking Device Materials (TD)	Delivery Mechanism Materials (DM)
Dialogic Teachers	*CCSSM and TR Alignment*: Interpreted materials as aligned with CCSSM	*CCSSM and TR alignment*: Interpreted materials as not aligned with CCSSM
	MPs: Attended to MPs in CCSSM and decided to feature these through open problems and investigations.	*MPs*: Attended to lack of focus on MPs, interpreted as limiting students' opportunity to learn, and decided not to not use or substantially adapt TR.
	TR Feature, Problems and Homework: Attended to and worked problems as students might to anticipate their thinking, strategies, and confusions (interpreting and deciding). Selected problems to align with big and with MPs (interpreting and responding).	*TR Feature, Problems and Homework*: Attended to problems and homework, interpreted as focused on skills and as not deep enough to induce reasoning, conjectures, and explaining. Decided to adapt or replace or only use in limited ways for practice.
	TR Feature, Lesson and Participation Structures: Attended to Launch-Explore-Summary (L-E-S) structure. For each phase considered key questions and approaches to engage students in productive struggle, communicating, and justifying (interpreted). Decided to launch the lesson with key questions and contexts, how to use cooperative groups, and how to facilitate a summary discussion.	*TR Feature, Lesson and Participation Structures*: Attended to the role the curriculum materials and the teacher played in presenting ("telling") students what steps to use to solve problems, with time for students to practice similar problems. Interpreted the heavy focus on whole group and practice as limiting students' development of understandings and engagement in MPs. Decided to substantially adapt or replace approaches from TR.
Direct Teachers	*CCSSM and TR alignment*: Interpreted materials as aligned with CCSSM	*CCSSM and TR alignment*: Interpreted materials as aligned with CCSSM
	MPs: Attended to MPs, interpreted as different from designated materials, decided not to use the TR approaches related to mathematical practices due to perceived time needed and/or needing to cover "basics" first.	*MPs*: If attended to CCSSM, attended to content standards (not MPs), interpreted as topics to be covered, and decided to cover standards by following TR (showing procedures and providing time for practice).
	TR Features Problems and Homework: Attended to inquiry-based approaches, interpreted as "overwhelming" for planning and students, and decided problems were beyond their students' capabilities. Decided to adapt or replace with practice problems.	*TR Feature, Problems and Homework*: Attended to problem sets as a first-step in planning, selected problems based to match students' current skills and to practice new content (interpreting and deciding).
	TR Features, Lesson and Participation Structures: Attended to the L-E-S	*TR Features, Lesson and Participation Structures*: Attended to examples to

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	structure. Interpreted that students need more direct instruction and practice, viewed investigations as too challenging for students and requiring too much time. Decided to scaffold and model problems first and supplement to ensure that students had skills, procedures, and practice needed before attempting investigations.	model and problems to assign for individual seatwork and/or homework. Decided on examples, what to model, how to talk through the problem solving process, key steps to emphasize, and key cautions to share. Decided on errors to look for when students were practicing problems and ways to correct or prevent these errors.

Discussion and Implications

A growing body of evidence indicates that characteristics of curriculum impact teaching and learning (e.g., Stein, Remillard, & Smith, 2007; Tarr et al., 2008). Indeed, we found that teachers' orientations matched the type of curriculum they were using in most cases. For the three teachers whose direct orientation was different from the approach of their TD materials, they attended to differences in the curriculum approaches, but then discussed how they were "struggling" to plan lessons as TR suggested, and often supplemented with practice problems from past DM resources. This pattern and other findings above indicate that a TD curriculum can support teachers' dialogic orientations in planning and incorporating CCSSM (and especially the MPs). However, similar to past reform efforts, the CCSSM and curriculum materials can be interpreted and enacted in multiple ways (Coburn, Hill, & Spillane, 2016; Remillard, 2005; Spillane & Zueli, 1999). Teachers also might attend to differences and then decide to plan based on their past practices or past materials. Teachers need support (e.g., professional development, coaching) and time to enact TD lessons in ways that are consistent with goals for dialogic instruction. This study is a next step in understanding specific ways teachers notice and interact with different types of TR and with CCSSM. This can inform both curriculum developers in designing curriculum and teacher educators in preparing teachers to enact ambitious practices.

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