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Going Beyond the Provided Curriculum:
Teachers' Investigations of Outside Mathematics Materials

by

Anna Joyce Casey

A dissertation submitted in partial satisfaction of the

requirements for the degree of

Doctor of Philosophy

in

Education

in the

Graduate Division

of the

University of California, Berkeley

Committee in charge:

Professor Geoffrey Saxe, Chair
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Professor Susan Stone

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2016

Abstract

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Doctor of Philosophy in Education

University of California, Berkeley

Professor Geoffrey Saxe, Chair

Elementary school teachers in the United States are typically provided curricular materials by their school districts. However, little is known about how teachers may replace or supplement these provided materials with *outside materials*—materials found in their own curricular libraries or from external sources. This dissertation proposes a research framework on teachers' use of outside materials that leads to the following research questions: What motivates teachers to consider using outside curricular materials? What approaches do they use to discover outside materials? What criteria do they use to evaluate outside materials? What steps do they take to prepare or adapt outside materials? And what external factors relate to teachers' decisions to use outside materials? These questions were addressed through an online survey of 98 elementary teachers across two districts in Western Washington state, interviews with nine survey respondents who frequently considered using outside materials, and in-depth case studies of the decisions of three interviewees. The survey revealed that a large majority of teachers considered using outside curricular materials at least once in the 2015-2016 school year, that many of them did so frequently, and that their reasons for considering outside materials were linked to areas of dissatisfaction with the provided materials. A multiple linear regression found that higher teacher-reported feelings of curricular autonomy and more years of experience with their provided curriculum predicted higher frequency of considering outside materials. The survey also revealed that teachers used a wide variety of approaches to discover outside materials, including both online and offline methods. Interviews provided detail to these findings, revealing that teachers' evaluation criteria were aligned with their initial motivation to consider outside materials, and that teachers tended to engage in minimal preparation of outside materials. Case studies of three focal teachers were used to illustrate different motivations for considering outside materials and different approaches for discovery, as well as to elaborate and refine the research framework that guided this investigation. This dissertation adds to literature showing that teachers actively participate with curricular materials in order to reach their professional goals, and makes a strong case for including attention to outside materials in curriculum development, district-level decisions, and future research.

Dedication

This dissertation is dedicated to the members of the Learning Mathematics through Representations research group. Thank you all for introducing me to the wide world of math curriculum, for consistently providing thoughtful feedback, and for being an endless source of support.

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There is no way I could have completed this dissertation without the guidance and support of my community.

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Chapter 1: Introduction

Research that investigates teachers' use of curricular materials for mathematics has primarily focused on materials that are provided by schools, districts, or research teams. This sole focus on provided materials leaves out instances in which teachers may discover and use other curricular materials. As such, we know very little about how teachers make decisions around using *outside*¹ *curricular materials*—curriculum units, lesson plans, activity ideas, worksheets, and other materials that are not provided to teachers by schools or districts, but instead are found within teachers' own libraries or from external sources. This dissertation is designed to take a first step in examining elementary teachers' decisions around using outside curricular materials for mathematics. To do this, I present a research framework along with survey and interview data that aim to reveal teachers' motivations for considering outside materials, their approaches to discovering outside materials, the criteria by which they evaluate outside materials, and the ways in which they prepare or adapt outside materials to fit their classroom.

Although there are ways in which teachers' decisions around outside materials are likely to be similar to their decisions around provided materials, the use of outside materials has several unique elements that raise the five research questions of this dissertation. (1) What motivates teachers' consideration of outside materials, and in what situations do they decide to use outside materials? The decision to use provided materials (with their institutional sanction and ready availability) is likely motivated by very different factors than the decision to use outside materials (which may not be readily available and may not have any specific sanction). (2) Once teachers have made the decision to consider outside materials, what approaches do they use to discover relevant ones? This is an area completely unexplored by current research, as provided materials do not require discovery. (3) Once teachers have discovered an outside material, what criteria do they use to evaluate it? Although it is possible that teachers simply judge all curricular materials by the same criteria, it is likely that there are criteria specific to outside materials (potentially linked to teachers' motivation for considering them in the first place) that are highly influential. (4) Once teachers have evaluated an outside material highly and decided to use it, what steps towards preparation or adaptation do they make? All curricular materials require preparation, but given differences in the ways that provided and outside materials are presented to teachers and supported by institutions, there may be significant differences in how teachers approach preparation and adaptation of outside materials. (5) Which factors that are external to the materials (such as characteristics of the teacher or the context in which they teach) relate to teachers' decisions to use outside materials? Although some factors (such as teachers' views of math learning) may relate to both provided and outside materials similarly, others (such as teacher's feelings of curricular autonomy) may be unique to the decision to use outside materials.

The findings from this new strand of empirical inquiry will enhance the field's understanding of teachers' decisions around curricular materials, and have specific implications for supporting teachers, district administrators, and curriculum developers. For example, identification of the most effective approaches and tools for discovering quality outside materials could support teachers who feel unable to find useful resources with their current approaches.

¹ I use the term "outside" rather than "supplemental" to account for schools that may provide both comprehensive and supplemental materials (here considered "provided materials"), as well as teachers who may use a

District-level data could provide feedback to administrators on ways in which their policies support or constrain teachers' decisions to incorporate outside materials, as well as areas in which teachers could use additional professional development (e.g., on understanding the affordances of the provided curriculum, or on critically evaluating outside materials). Finally, identifying common instances in which teachers use outside materials could help developers of the provided curriculum revise future editions, resulting in materials that are more highly usable by teachers, and that would require less supplementation, or that could be more easily integrated with outside materials.

To frame this study on teachers' use of outside curricular materials, I have partitioned this introductory chapter into four main parts. First, I make a case for why use of outside curricular materials is likely a common teacher practice. Second, I describe the limited existing evidence regarding teachers' use of outside materials. Third, I propose a research framework of teachers' curricular decision-making that builds off of existing perspectives on curriculum use, and explore existing questions regarding each aspect of the decision-making process. Fourth, I consider how this process may occur differently depending on the influence of external factors. Finally I articulate the specific goals of this dissertation, and provide an overview of its structure.

Teachers' Use of Outside Materials: Why This Is Likely A Common Practice

Although there is no data on the prevalence of elementary teachers' use of outside materials for mathematics, there are several reasons to suggest that using outside materials is a common practice, each of which are explored in this section. First, when planning for and enacting lessons, teachers are known to both omit and supplement provided materials, providing ample opportunity to supplement with outside materials (e.g., Choppin, 2011a; Chval, Chávez, Reys, & Tarr, 2009). Second, the current context of CCSS has created a mismatch between some provided materials and math standards, spurring teachers' need for aligned-materials. Third, the proliferation of the internet along with online sources of curriculum materials has created a new opportunity for teachers to find, share, critique, and enact outside materials. In this section I explore each of these areas, identify how the process of using outside materials is likely to differ in important ways from the process of using provided materials, and illustrate how this study will address gaps in the research literature.

Teachers are known to supplement their provided materials. A great deal of research has emerged over the past decade illustrating how teachers participate with (Remillard, 2005), rather than simply implement, curricular materials. This work has often focused on describing how teachers both omit and supplement provided materials (Choppin, 2011a; Chval et al., 2009; Sherin & Drake, 2009; Tarr et al., 2006), but studies only occasionally distinguish between instances in which teachers use or adapt existing materials and those in which they supplement with additional activities (e.g., Brown, 2009; Son & Kim, 2015; Taylor, 2012). Even among studies that distinguish between existing materials and supplemental ones, they do not describe which of these supplemental materials teachers created based on their experience and which they discovered from outside sources.² I argue that focusing on provided materials, and grouping all supplemental materials together constitutes an under-conceptualization of teachers' decision-making around curricular materials. This inhibits our ability to fully understand teachers'

² Taylor's work (2010, 2012) comes close to making the distinctions described here, as her category for "created" materials specifies only materials created by teachers that do *not* originate from other sources; however, her categories for "existing" and "adapted" materials do not distinguish among sources (i.e., provided by schools or discovered from an outside source).

curricular decisions, as the use of provided materials does not require many of decisions and skills that are involved when using outside materials. For example, when teachers first consider using an outside material, they may spend time deciding whether it would be more efficient to search for an outside material or create a material from scratch. If they decide to search for an outside material, their knowledge of available resources and their skill in searching for relevant materials will impact the quality of their discoveries. Teachers may also have to decide whether they should consider only free resources, or if it is worthwhile to invest personal funds into materials. In addition to these decisions and skills that are unique to the use of outside materials, the professional and institutional contexts that affect teachers' decisions are likely to differ depending on the source of the curricular materials (e.g., teachers may experience high levels of support for their use of provided materials, but very low levels of support for their use of outside materials). This study is designed to uncover these underexplored teacher decisions and skills, and shed light on how they may be related to factors that are external to the materials.

Provided materials may not sufficiently align with current standards. The adoption of the Common Core State Standards for Mathematics (CCSS-M, National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010) has created a context in which teachers may be more likely to consider outside materials, and which existing research has not fully explored. Because new standards are often adopted before revised curricular materials have been published, many teachers are currently experiencing a need for materials that are well-aligned to the Common Core State Standards for Mathematics (CCSS-M, National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010). This delay between the adoption of standards and the adoption of new curricula has put teachers in the position of attempting to meet current standards using old un-aligned materials (Kober & Rentner, 2012; Schmidt & Houang, 2014), and has created a new impetus for teachers' use of outside materials (Webel, Krupa, & McManus, 2015). Furthermore, some evidence suggests that a large portion of new curricular packages that are marketed as aligned with the CCSS-M, are actually not aligned, aligned only in superficial ways, or aligned only for certain grade levels (Cogan, Schmidt, & Houang, 2013; Meyer, 2015; Polikoff, 2015). For example, evidence suggests that while curriculum developers were fairly successful at re-ordering the scope and sequence of the K-5 standards to align with CCSS Mathematical Content standards, many curriculum packages have been less successful at authentically integrating rich opportunities to develop all of the CCSS Mathematical Practices. Thus even teachers who have been provided with new materials may still find themselves with a need to seek outside materials in order to prepare their students according to the new standards. In this study, teachers have the opportunity to describe their reasons for considering outside materials, and comment on how their use of materials may have changed in response to the CCSS-M.

Access to outside materials has grown with increased access to the internet. Another reason teachers are likely to use outside materials is the notable increase in access to the internet both in public elementary schools (Gray, Thomas, & Lewis, 2010; Parsad & Jones, 2005) and at home (Horrihan, 2012), which has in turn increased teachers' access to outside curricular materials. Prior to the proliferation of the internet, access to materials was oftentimes limited by physical proximity; although phone calls might permit teachers to share general lesson ideas, and fax machines or postal mail could allow for the spread of some physical materials, teachers more often had access to outside curricular materials through the teacher communities at their school, including their direct predecessor (Diekema & Olsen, 2012) or potentially through workshops and conferences. Now, there are numerous online sources of curricular materials (both digital

and non-digital) made available by teachers, mathematics education organizations, and not-for-profit organizations (e.g., teachers' personal blogs, Gooru's search engine for materials, websites by the National Council of Teachers of Mathematics, and Khan Academy's video lessons). Additionally, services like Edmodo encourage teachers to create lessons and assignments by gathering online materials from various sources. This proliferation of the availability of outside materials has created a context in which it may be easier for teachers to incorporate an outside material that fits their needs, than to create such a material from scratch. This suggests that even if early research on teachers' supplementation of provided materials did not distinguish between sources of those materials, this is an important area of focus in the current educational context.

Teachers' Use of Outside Materials: What We Know

Here, I look back at the limited existing research on teachers' use of outside materials, and then look forward to anticipate some unique challenges that the use of outside materials is anticipated to present. As described earlier, most research on teachers' curricular decisions focuses on materials that are provided to teachers. A limited body of research has examined teachers' use of outside materials, however this literature has multiple limitations that prevent a full picture of teachers' decisions in this area. In this section, I describe the limitations of existing research on outside materials, explain how the current study addresses those gaps and illustrate how this study will provide important information to help mitigate potential challenges posed by the use of outside materials.

Addressing limitations of existing research on outside materials. Emerging research confirms that teachers do use online resources when teaching mathematics (Davis, Choppin, McDuffie, & Drake, 2013; Hanson & Carlson, 2005; Recker, Dorward, & Nelson, 2004; Webel et al., 2015), however these studies are narrow in scope in that they focus on only online resources (rather than include offline outside resources) and that they focus entirely on middle- and high-school teachers (rather than include elementary teachers). By narrowing the scope of outside materials to include only those found online, existing research fails to include full array of outside materials that teachers may discover from other teachers, at conferences, and their own curricular libraries. By narrowing the focus of teachers' mathematics curricular decisions to include only middle- and high-school teachers, existing research fails to include important contextual and personal factors that may impact teachers' decisions. The decisions of a teacher planning for multiple disparate subjects each day (such as elementary teachers do), are likely to be affected by different factors than the decisions of a teacher planning for only one or two math-related courses each day (such as many middle- and high-school teachers do). Additionally, middle- and high-school math teachers are more likely to have math-centered professional identities, whereas there is evidence that preservice elementary teachers demonstrate high levels of math anxiety (e.g., Hembree, 1990). This suggests that elementary teachers may be in even more need of support for engaging in the complex process of incorporating outside mathematics materials. My dissertation aims to fill these gaps in the research literature by including a broad range of outside materials, and by focusing specifically on the decisions and needs of elementary teachers.

Addressing challenges that arise from the proliferation of outside materials. Earlier, I described that one of the reasons why teachers are likely to use outside materials is that access to outside materials has increased along with increased access to the internet. Although there are many reasons to see this as a positive development, this increase in access is also likely to bring along accompanying challenges with using outside materials. Among those materials found online, and even among materials recommended by other teachers, only a fraction of materials

will align with a particular teacher's professional goals and incorporate research on pedagogy and student learning in more than superficial ways. The proliferation of outside materials could thus be considered a double-edged sword: Teachers can save time that would be spent on creating new materials by finding already-created materials and can benefit from the revision process that has already gone into refining those materials (e.g., some teacher resource websites provide the opportunity for users to rate, review, and post revisions of materials), however teachers can also get stuck spending significant amounts of time searching for those relevant and well-developed materials. Thus with increased availability of materials also comes an increased need for teachers to utilize efficient approaches to discover high-quality materials, and for teachers to develop skill at evaluating potential materials based on their professional goals (a process described, in part, as "curricular noticing" by Dietiker, Amador, Earnest, Males, & Stohlmann, 2014). This points to the need for increased focus on topics addressed by this study, such as: What discovery approaches teachers find useful, what types of materials they find them useful for, and what characteristics teachers consider when evaluating whether a material is worthy of incorporating in their classroom.

Teachers' Decisions around Using Outside Materials: A Proposed Process

In this section, I introduce the framework that guides this study on teachers' decisions around outside curricular materials. This framework was initially developed based on a review of literature on teachers' use of curricular materials, as well as informal experience with and observations of teachers' curricular decisions. It was later used to guide the structure of a pilot study, and was refined based on the results of that investigation. In the current study, this framework serves three purposes: first, to elaborate the underexplored process of deciding to use outside curricular materials in math; second, to provide an organizing framework for the design of the study materials; third, to structure the presentation of the results and thereby illuminate areas in which the framework strongly represents teachers' decisions and areas in which it will benefit from revision.

Here I briefly describe previous conceptualizations of teachers' curriculum use that distinguish between different types of curriculum (Center for the Study of Mathematics Curriculum, n.d.; Remillard, 2005; Remillard & Heck, 2014) in order to situate the current study and motivate the need for the proposed framework. Although subtle distinctions and terminology vary, these previous models of teachers' curriculum use tend to acknowledge several types of curriculum, including: the designated curriculum (outlined by state curriculum standards), the assessed curriculum (ways in which the intended curriculum is assessed to monitor learning outcomes), the textbook curriculum (curricular materials provided to the teacher by the school), the teacher-intended curriculum (the product of teachers' participatory interactions with curricular materials and standards), the enacted/implemented curriculum (what actually happens in the classroom among teachers, students, and materials), and the learned curriculum (aka student outcomes, what students take from the lesson). The overlap between the textbook curriculum and the teacher-intended curriculum is where the current study resides, and is a space also referred to as the design arena (Remillard, 1999). The design arena acknowledges teachers' roles as developers of curriculum, and is where teachers select and design the mathematical tasks intended for lessons. Initial research on teachers' decisions in the design arena focused on teachers' appropriation of tasks (using tasks presented in the textbook) and teachers' invention of tasks (creation of new tasks without a specific source), but did not include any examination of teachers' decisions to incorporate outside materials. Thus, the current framework is intended to guide this initial investigation of teachers' decision-making around

outside curricular materials. The framework shown in *Figure 1* outlines a proposed process of decision-making that is organized into four phases: consideration, discovery, evaluation, and preparation/adaptation of outside materials.

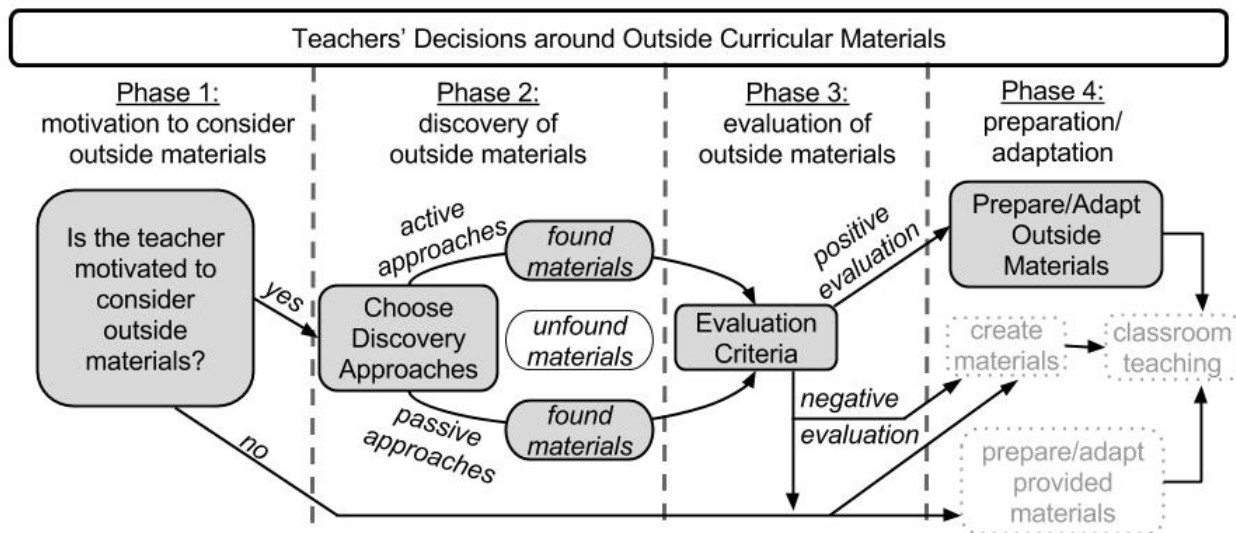


Figure 1. Research framework of teachers’ decisions around outside curricular materials.

In Figure 1, Phase 1 represents a time period during initial planning (of a lesson, a unit, or even the entire school year), in which a teacher may become motivated to consider outside curricular materials. Teachers who are not motivated to consider using outside materials are presumed to bypass the discovery and evaluation phases, and instead default to using and adapting the provided materials, or creating their own materials (represented by the “no” line leading to the shapes on the right side of the figure with light gray dotted outlines). Teachers who *are* motivated to consider using outside materials are next tasked with discovering those materials. In Phase 2, teachers may use one or more discovery approaches (indicated by the curved arrows coming from the “Choose Discovery Approaches” box in Figure 1). These could include a mix of active approaches (such as performing online searches for specific content) and passive approaches (implementing systems that bring potentially relevant materials to them, such as subscribing to a math teaching newsletter). Teachers’ choice of approaches, as well as their skill with using these approaches, are theorized to influence which outside materials will become found (represented by the two gray shapes that overlap discovery arrows), and which potential materials will remain unfound (represented by the white shape with no discovery overlap). In Phase 3, teachers evaluate the outside materials according to their professional goals and other criteria that are important to their specific needs at that time. Materials that are evaluated negatively are not taken up, leading teachers to return to the default provided materials, or to spend time creating their own materials. Materials that are evaluated positively are then prepared and possibly adapted during Phase 4, before being used in classroom teaching. These last two phases (evaluation and preparation), describe decisions that also occur during the use of provided materials, while the first two phases (motivation and discovery) are unique to the consideration of outside materials.³

³ To be clear, I conceptualize the practice of using outside curricular materials as inherently neither positive nor negative for promoting equitable student learning—“good teaching” can occur both with and without the use of

This framework is intended to guide this exploration of teachers' thinking and decision-making processes at each phase, but it is not intended to illustrate every aspect of the process, nor how the process proceeds for every teacher every time. Although the framework is represented as a sequence of phases, it is likely that the process often occurs in a non-linear fashion that is not fully represented in Figure 1. For example, if teachers are having difficulty finding materials that they evaluate highly enough to use, they may cycle between the discovery and evaluation phases repeatedly. If they evaluate found materials negatively and decide to create new materials instead, they may begin this task, but discover that they don't have time to see it through to completion, thereby increasing their motivation to consider outside materials and re-entering the process. Rather than including all possible combinations of two-way and recursive arrows, the general framework is illustrated in a linear manner. The framework is also not intended to be exhaustive of all aspects that relate to teachers' decision-making around outside materials. Notably, the framework includes very little about curriculum developers, students, and teacher communities, in part because the current study is not designed to provide sufficient information about their potential roles in the process. However, this investigation does provide information on external factors that may influence teachers' decisions throughout the process. The following sections specify the research questions that are central to each phase of the proposed process of teachers' decisions around outside materials: consideration, discovery, evaluation, and preparation/adaptation. In each of these sections, I also connect each phase to existing research, illustrate how the phase is defined in the framework, and present hypotheses and implications of the current study.

Phase 1: What motivates teachers to consider using outside materials? The framework that guides this research starts with the presumption that in order for teachers to consider using outside curricular materials, they must have motivation to do so. Thus the first question addressed by the current study is: What motivates teachers to consider using outside materials? Other basic but important questions related to this phase (Phase 1 in *Figure 1*) include: how many teachers consider using outside materials, and how frequently do they do so?

Consideration of outside materials: Existing information. Although there is little existing research on teachers' decisions to use outside materials, research showing that teachers regularly adapt provided materials (through both omission and supplementation) provides some insight into their motivations to adapt. Research shows that decisions to adapt are related to teachers' views of math learning and their goals for math teaching (Choppin, 2011b; Son & Kim, 2015), their district policies (Chval et al., 2009), their local standards (Tarr et al., 2006), and their degree of experience with the provided materials (Drake & Sherin, 2009). Recent research on middle-school teachers' use of online resources indicates that many teachers were motivated by a need to find materials that are aligned with CCSS-M standards (Davis et al., 2013; Webel et al.,

outside materials. Instead, I argue that the outcome of this practice depends on the specific adaptations that are made, as well as the teacher's ability to use the materials to scaffold the learning of all students. For example, a teacher could make very few adaptations to a set of provided curricular materials, resulting in few opportunities to learn for ELL students, or that teacher could make many adaptations by including outside materials that reduce the English language demands to support more equitable access. Similarly, another teacher could use only the provided curriculum and personal knowledge of student thinking to promote student engagement and understanding, or that teacher could adapt tasks to reduce the focus on student thinking and introduce outside materials that focus on memorizing algorithms. Therefore, this framework for teachers' decisions around outside materials serves to unpack and examine teachers' practices, rather than to advocate for a particular level of use of outside materials.

2015), while older research on online resources describes a desire for efficient ways to meet the academic needs of students (Recker et al., 2004). The current study is designed to expand upon this work by attending specifically to teachers' decisions around outside materials (both online and offline), and examining whether the associated motivating factors are similar to or different from the factors that motivate adaptation of provided materials.

Consideration of outside materials: In the current study. This study aims to fill gaps in the existing research literature by describing how frequently elementary teachers are motivated to consider outside curricular materials for math, as well as the primary reasons behind their motivation. Although the framework presents this phase as a dichotomous question ("Are teachers motivated to consider outside materials, yes or no?"), the strength of teachers' motivation to consider outside materials is assumed to lie along a continuum. Teachers who reporting considering outside materials very frequently are thus assumed to have stronger motivation to consider outside materials than teachers who consider outside materials less frequently. In order to better understand how teachers' motivation to consider outside materials may link to their provided materials, teachers are also asked to describe one thing they would change about their provided materials.

Consideration of outside materials: Hypotheses and implications. Although the lack of existing research on teachers' motivation to consider outside materials leaves this component of the study largely exploratory, one specific hypothesis is that teachers are motivated to consider outside materials due to dissatisfaction with their provided materials. Because provided materials are readily available and are sanctioned (if not required) by teachers' schools or districts, this hypothesis posits that teachers would adhere closely to the provided materials if it were not for significant elements of dissatisfaction. If this is the case, better understanding of these areas of dissatisfaction can help district specialists and curriculum developers do three things: (1) revise or develop materials in line with the identified needs of their teachers, (2) revise materials to highlight aspects of the provided materials that may already meet the need, and/or (3) search for, evaluate, and suggest outside materials that meet those same needs. For example, if many teachers in a district are motivated to consider outside materials because of a perceived need for materials that support Common Core Standards for Mathematical Practice (e.g., constructing and justifying mathematical arguments), the district curriculum specialists may decide to find or develop materials aligned with this goal. Alternatively, they may decide to create professional development sessions that support teachers in identifying and utilizing existing aspects of the provided curriculum that may not have been sufficiently highlighted in the materials.

Phase 2: Where and how do teachers discover outside materials? For teachers who do consider outside materials, they move on to Phase 2 in *Figure 1* and prompt the next research question of this study: How do teachers discover outside materials?

Discovery of outside materials: Existing information. This is an area in which existing research is particularly lacking given the field of education's focus on provided materials, which do not require discovery. Focus for this area is informed by pilot work, as well as research in the field of information science and technology that has found that teachers build curricular libraries by inheriting and retaining materials, asking colleagues, subscribing to mailing lists, and searching online (Diekema & Olsen, 2012; Recker et al., 2004).

Discovery of outside materials: In the current study. This study will provide a first step into exploring teachers' approaches towards discovering outside materials, including how frequently they use a wide variety of approaches, and their reasons for preferring these

approaches. I use the term “discover” rather than “search” to account for a broad range of approaches, including those that do not involve purposeful or active search, but that allow teachers to come across outside curricular materials. The current study is designed to uncover how teachers may arrange passive systems that lead to the discovery of outside materials such as subscribing to teaching blogs, making a habit of attending local conferences, or simply accepting unsolicited recommendations from colleagues. This study also asks teachers about their active approaches towards discovering curricular materials such as asking teachers or math coaches at their school, performing online searches, posting requests to other teachers through social media, and searching through their own curricular libraries.

Discovery of outside materials: Hypotheses and implications. There are no specific hypotheses regarding teachers’ use of discovery approaches, other than the expectation that teachers who consider outside materials will discover them using a variety of approaches, both active and passive, online and offline. Although it is outside the scope of the current study to measure teachers’ skill with discovery approaches, the results from this study are intended to provide some useful groundwork for future research to investigate the construct of teachers’ “discovery skills.” The type of discovery approaches teachers use and the ways in which they use them, are theorized to impact the materials they discover and subsequently evaluate. If a teacher uses a limited number of discovery approaches or uses them in very narrow ways, relevant materials may be left “unfound,” as depicted in Figure 1. Similarly, a teacher who is unskilled with a particular discovery approach (e.g., uses overly broad search terms), may find materials of lower relevance or quality, and spend more time than necessary engaged in repeated searches or adaptations. Therefore, a better understanding of the types of discovery approaches that teachers use and the ways in which they use them will serve teacher educators who could then develop trainings on discovery skills. Additionally, if developers of outside curricula find that their materials are only discoverable with one or two discovery approaches, or with very specific use of a certain discovery approach (e.g., requires overly specific online search terms), they can take action to make their materials more widely discoverable by teachers.

Phase 3: How do teachers evaluate potential outside materials? Once teachers have discovered outside materials, they then evaluate those materials (Phase 3 in *Figure 1*), prompting the next question: What characteristics are important to teachers as they evaluate outside materials?

Evaluation of outside materials: Existing information. Existing research on teachers’ evaluations of curricular materials includes research on how elementary math teachers evaluate provided materials, and how teachers of older grades evaluate online materials. Research on provided materials has often taken a detailed approach, distinguishing between processes of “reading” (examining materials) and “evaluating” (judging the utility and quality of the materials by the teacher’s criteria) (Sherin & Drake, 2000), and between teachers’ evaluations before, during, and after instruction (Drake & Sherin, 2006; Sherin & Drake, 2009). Research on middle- and high-school teachers’ evaluations of online materials found that they evaluate materials highly when they are aligned with student’s needs (e.g., age-appropriate and engaging), are aligned with standards, contain familiar approaches, include useful features (such as worked examples), and require little adaptation (Recker et al., 2004; Webel et al., 2015). Although these bodies of literature have not included investigation of elementary teachers’ evaluations of outside materials, they have informed the design of the current study.

Evaluation of outside materials: In the current study. The research framework used in this study incorporates features of prior work but differs in two key ways. First, it illustrates a

single evaluation phase (rather than separating into subordinate processes as is common in the literature on provided materials), however interview questions were designed to uncover how teachers engage in “reading” (e.g., skimming through materials, focusing in on particular elements, etc.) as well as “evaluating” (by asking about specific criteria that are important to teachers). Particular emphasis is placed on the evaluating step by asking teachers to identify the most influential factor on their decision to use an outside material. Second, rather than collecting data before, during, and after evaluations, the current study focuses primarily on teachers’ evaluations *before* instruction, in order to focus on and describe the process of deciding to use an outside material. However, the interviews were conducted retrospectively in such a way that allowed the opportunity to contextualize responses in actual uses of outside materials. This also allows teachers to describe how they evaluated the materials *during* and *after* instruction (e.g., if they found the materials to be successful, if they would use the materials in the future, and what changes they would make).

Evaluation of outside materials: Hypotheses and implications. It is hypothesized that teachers’ evaluations of outside materials will be highly influenced by whether or not the materials address the perceived deficiencies of their provided materials. This hypothesis is tied closely to the initial hypothesis that teachers are motivated to consider using outside materials due to dissatisfaction with the provided curriculum. Thus, materials that “shore up” these deficiencies of the provided materials are more likely to be evaluated highly and put into use. Based on research in related areas as well as pilot work, it is also hypothesized that teachers will place strong emphasis on the recommendations of trusted colleagues (perhaps because outside materials are less likely to come with introductory and educative text), and that teachers will have negative evaluations of materials that require significant additional time to prepare or enact (due to the time already involved in discovering outside materials and adapting the provided materials to accommodate the additional materials). Understanding how teachers evaluate outside materials has implications for those who are trying to encourage the use of specific outside materials. If teachers are found to tie their evaluations of outside materials to gaps left by the provided curriculum and recommendations of colleagues, district math specialists who are trying to promote new instructional strategies may choose to pilot related materials with a subset of respected teachers, and incorporate their testimonials during professional development sessions. Similarly, developers of outside materials (whether large research teams or individual teachers) may use these findings to highlight how their materials improve upon common flaws of textbook programs, and provide a space for teachers to leave feedback.

Phase 4: How do teachers prepare or adapt outside materials? After teachers have evaluated an outside material highly, but before they begin using them in the classroom, they are likely to engage in at least some preparatory activities (Phase 4 in *Figure 1*). This prompts the question: How do teachers prepare or adapt outside materials before using them in their classrooms?

Preparation of outside materials: Existing information. Research on teachers’ decisions around provided materials shows that they often engage in extensive preparation activities in order to reach their goals both within and across instructional sequences (e.g., Brown, 2009; Choppin, 2011b; Drake & Sherin, 2006; Remillard, 2005; Taylor, 2012). Limited research on teachers’ use of online outside materials shows that given pressures on time, teachers engage in minimal adaptation of these materials; for example they may group various materials together, or adjust certain aspects of the materials to meet various student ability levels (Recker et al., 2004).

Preparation of outside materials: In the current study. The framework of the current study acknowledges that teachers do not simply implement the materials that they choose to use, but they participate with these materials in planned and unplanned ways. In the current study, teachers are asked to describe what preparatory activities were required in order to put the outside materials to use in their classrooms (e.g., making copies, buying required manipulatives, securing approval, or researching unfamiliar content). They are also given the opportunity to describe any changes they made to the outside materials, and contrast this with adaptations made to provided materials. Although the self-report nature of the current study necessarily focuses on teachers' conscious adaptations, the framework recognizes that additional and often unconscious adaptations occur during enactment, which is outside the scope of this study.

Preparation of outside materials: Hypotheses and implications. Due to the lack of research on how elementary teachers adapt outside materials, there are no specific hypotheses about the level or type of adaptations that teachers will report regarding outside materials. Teachers may make few adaptations if they have weeded out materials that require extensive modification during the evaluation phase. Alternatively, teachers may make many adaptations in order to meet the specific goal that motivated them to consider outside materials in the first place, or simply because they feel less beholden to using the materials with fidelity (given that they are not "assigned" by their district). Understanding the adaptations that teachers make when using outside materials can provide additional insight into their motivations for incorporating those materials in the first place, as well as the criteria by which they evaluate the materials. For example, a teacher may consciously decide to search for materials that provide more opportunities to create and justify mathematical arguments, and then make adaptations to scaffold those materials for English language learners and students with IEPs, thus revealing another goal and potentially another criteria by which materials are evaluated.

What External Factors Relate to Teachers' Decisions to Use Outside Materials?

The final research question of this study does not reside in a phase of the proposed decision-making process, but instead it asks: What personal and contextual factors relate to teachers' decisions to consider outside materials?

Relating external factors to outside materials: Existing information. Research on the use of provided materials has highlighted a complex array of factors that influence teachers' participation with curriculum. This includes the national standards and market forces that influence the adopted/provided curriculum, as well as the beliefs that teachers and students hold about the nature of mathematics, learning, and teaching (Brown, 2009; Center for the Study of Mathematics Curriculum, n.d.; Remillard & Heck, 2014). Specifically, previous research has found that teachers with higher confidence in their own understanding of the subject matter are more likely and able to adapt materials (Jamieson-Proctor & Byrne, 2008; Nicol & Crespo, 2006); teachers' beliefs about math teaching and learning have been shown to be more influential on their use of materials than the materials themselves (Nicol & Crespo, 2006; Superfine, 2009); and teachers' life histories with mathematics, including their experiences as children and experiences with their own children influence their professional identities as well as their use and adaptation of curriculum (Drake, 2006; Drake & Sherin, 2006). Although it is likely that the factors that affect teachers' use of outside materials will be similar to those affecting use of provided materials, important differences between the processes of using provided and outside materials warrant additional research in this area.

Relating external factors to outside materials: In the current study. The current study provides an opportunity to explore personal and contextual factors that may influence teachers'

decisions to use outside curricular materials in mathematics. Teachers report their feelings self-efficacy for teaching math (via a survey measure adapted from Charalambous, Philippou, & Kyriakides, 2008), their perceptions of curricular autonomy (via a survey measure adapted from Pearson & Moomaw, 2006), their experience with the provided curriculum, and their beliefs about math teaching (via interview questions adapted from Munter, 2014). This will allow for an examination of how the proposed decision-process may be influenced by these personal and contextual factors (shown in Figure 2).

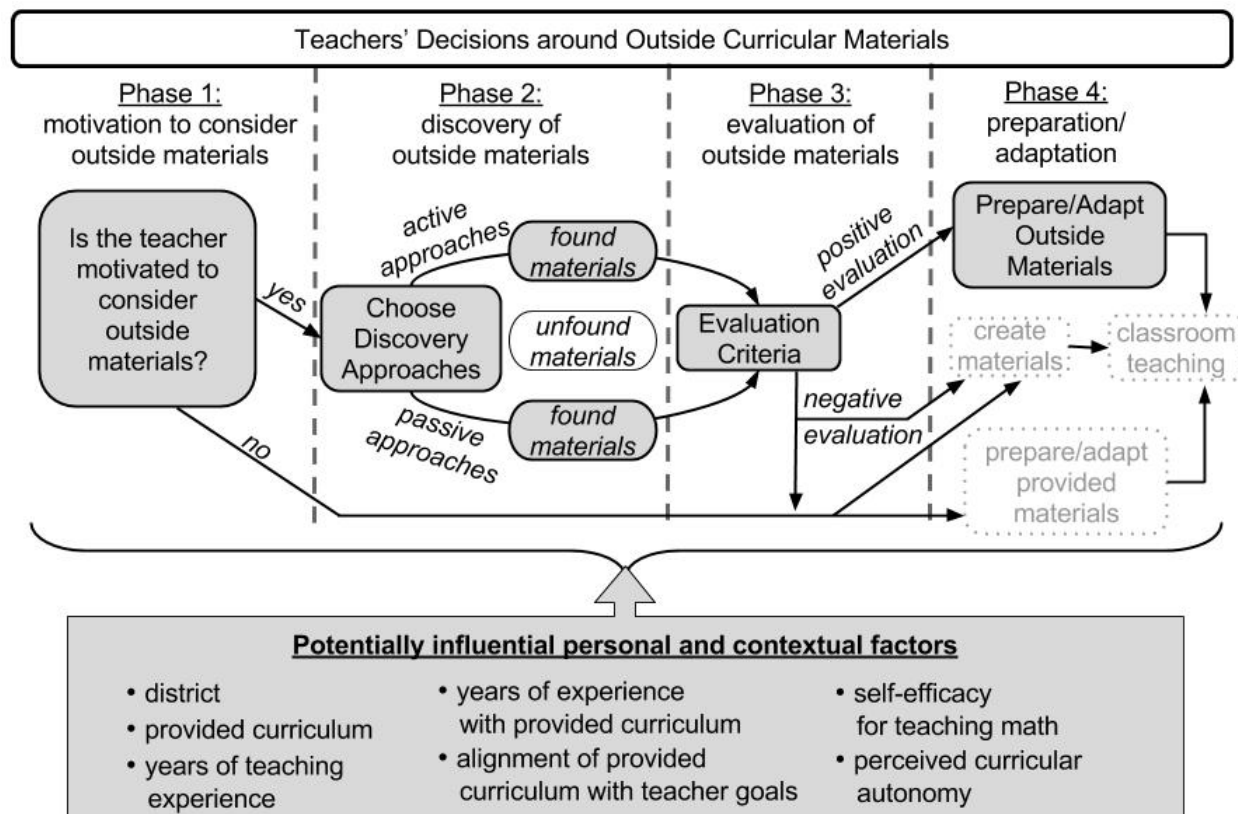


Figure 2. Factors that may influence the proposed research framework.

Relating external factors to outside materials: Hypotheses and implications.

Hypotheses regarding the influence of external factors center primarily around how these factors relate to teachers' motivation to consider outside materials. Specific hypotheses include: teachers with lower self-efficacy for teaching math will have decreased confidence in straying from the provided curriculum (with its institutional sanction and professional support) into outside materials (which require teachers to judge the value of and learn how to enact for themselves) (Stipek, Givvin, Salmon, & MacGyvers, 2001); teachers with lower perceived curricular autonomy will be less likely to consider and discover outside materials, as they may not feel that they have the freedom to adapt their provided curriculum (Stevenson, 2008); and teachers' years of experience with the provided curriculum may either lower their motivation to consider outside materials (due to increased experience with and trust of provided materials) (Drake & Sherin, 2006), or more years of experience may increase motivation to consider outside materials (due to a better understanding of the weaknesses of the provided materials) (Sherin & Drake, 2009). Additionally, teachers' goals for their mathematics teaching (which are informed by their students' needs and their own beliefs about teaching and learning) are

hypothesized to relate to their specific reasons for considering outside materials. Understanding the factors that influence teachers' decisions to consider outside materials can support districts that may want to promote or constrain teachers' use of outside materials. For example, if a district wants to promote the use of certain types of outside materials (e.g., those that encourage math talk among students), it may first need to develop training that influences teachers' beliefs about math learning (e.g., evidence that math talk promotes conceptual understanding).

Goals of the Investigation

Given that existing research has emphasized teachers' participation with curricular materials that are provided by schools, districts, or research teams, expanding research on curriculum use by focusing on materials that teachers discover from external sources or their own curriculum libraries is an important next step in the field. The goal of the current investigation is to explore teachers' decisions around outside materials, including their motivation to look outside of provided materials, contexts that enable and constrain this motivation, their use of various discovery approaches, their evaluation criteria, and their preparation or adaptation of outside materials. In alignment with the research framework described previously, this study aims to address the following research questions:

1. What motivates teachers to consider outside materials? (And how prevalent/frequent is the consideration of outside materials?)
2. Where and how do teachers discover these materials? (And which discovery approaches do they find most useful?)
3. What characteristics are important to teachers as they evaluate potential outside materials? (e.g., cost, ease of acquisition)
4. How do teachers prepare or adapt outside materials before using them in their classrooms?
5. How do factors external to materials (e.g., teachers' years of experience with the provided curriculum, perceptions of curricular autonomy, or self-efficacy for teaching math) relate to teachers' decisions to use outside materials?

Structure of the Dissertation

In this introductory chapter, I have described evidence that teachers' use of outside curricular materials is an under-conceptualized and under-researched area in mathematics education research, and proposed a research framework to guide this investigation of teachers' decisions around discovery and use of outside mathematics materials. In chapter 2, I present the methods used for this investigation, which include an online survey and semi-structured interviews with K-5 teachers. Chapter 3 focuses on analysis of the online teacher survey, which includes descriptive and inferential statistics as well as qualitative descriptions of themes in teachers' open-ended survey responses. Results of the survey indicated that many teachers considered using outside curricular materials for math, primarily to provide more engaging and differentiated activities for their students. In chapter 4, I provide brief descriptions of the nine teacher-interviewees, and go on to present themes in their decisions during each phase of the proposed decision-making process. In alignment with results from the survey, interviewees also highlighted the need for engaging materials, however notable differences emerged among teachers regarding which curricular attributes contribute to engagement for students. In chapter 5, I provide an in-depth look at the decisions of three focal teachers in order to illustrate three different conceptualizations of what constitutes engaging materials, three different approaches to discovery of outside materials, and three different types of outside materials. In chapter 6, I conclude by discussing how these findings build on existing research on teachers' curricular

decisions and relate to initial hypotheses. I also describe implications of these findings for the field of mathematics education research, for developers of curricular materials (both full textbook suites and standalone materials), and for district administrators tasked with overseeing instruction and curriculum use. This dissertation shows that many elementary teachers use mathematics materials that are not provided by their districts, and that they use a variety of approaches to discover and adapt these materials in order to reach their professional goals.

Chapter 2: Methods

Overview

This dissertation research uses a mixed-methods design with two primary data sources: (1) a brief online survey sent to a large number of teachers and (2) semi-structured interviews conducted with a selected set of nine survey respondents. The online survey focuses on the first two phases of the proposed process of teachers' decision-making (motivation to consider outside materials and discovery of outside materials), and also provides data on some personal and contextual factors that may influence teachers' decisions. Additionally, the survey was used to identify teachers who regularly consider using outside materials in order to invite them to participate in the interview. The interviews were designed to focus on the second two phases of the proposed decision process (evaluation and adaptation), and to provide more detail on how personal and contextual factors (such as teachers' beliefs about high quality mathematics teaching) relate to their decision-making regarding outside curricular materials. In the remainder of this chapter, I describe the participants, data sources, and procedures used in this study.

Participants

Survey participants. The final sample reported here includes 98 completed surveys from K-5 teachers in two districts in Western Washington. A total of 161 survey responses were collected, however 14 did not qualify for inclusion in the study based on the screening questions (13 did not teach mathematics at least three days per week and one did not teach only students in grades K-5), and 40 completed the screening and demographic questions but did not complete the survey. Nine additional respondents were excluded from analyses because they reported using a different provided material than the rest of the teachers in their district (remedial curricula used by Special Education teachers, an advanced curriculum used by teachers in self-contained gifted classrooms, and a curriculum written in another language used by teachers in a language-immersion school).

Interview participants. Interviews were conducted with nine teachers who regularly considered outside materials. A total of 21 survey respondents were invited to participate in interviews. Teachers were invited who met two selection criteria: (1) taught at one of three focal schools (schools with large numbers of respondents who regularly considered using outside materials), and (2) considered using outside materials at least once or twice per month. Three of the 21 invitees declined to participate (no reason for declining was provided), nine invitees agreed to participate (all teachers who agreed to participate completed interviews), and the remaining nine invitees did not respond to the invitation (see recruitment procedures below for additional details). Themes from all interviews are included in overall analyses; curricular analyses of specific materials are used to contextualize these themes and to illustrate the variety of outside materials that teachers used.

Data Sources

Survey. A 10-minute online survey was created to explore the first two phases of the proposed decision-making process around outside materials for math: teachers' motivation and their discovery approaches. Additionally, the survey was designed to provide data on several personal and contextual factors that may influence teachers' decisions, and was used to identify potential participants for the interview portion of the study. Administered through the online platform Qualtrics, the survey was divided into five sections: eligibility screening (only teachers who teach mathematics at least three days per week, and teach only students in grades K-5 were eligible), background information (e.g., school name, age), teaching career (e.g., years teaching experience, grade taught last year), curricular decisions (e.g., reasons for using or not using

outside materials; the largest section), and teacher characteristics (specifically, perceptions of mathematics curricular autonomy and feelings of self-efficacy for teaching math). Questions included multiple-choice items, Likert-type rating scales, and a limited number of free-response items (see Appendix A for details). The survey included an explanation of the terms “outside materials” and “provided materials,” and was refined through discussion with fellow researchers and piloting with local teachers.

Teachers’ self-efficacy and perceptions of curricular autonomy (for teaching mathematics) were measured using established instruments. The self-efficacy scale was adapted⁴ from Charalambos, Philippou, and Kyriakides (2008) and consisted of 12 items rated on a 9-point scale ($\alpha = .92$), (see Question #29 in Appendix A). The curricular autonomy scale was adapted⁵ from Pearson and Moomaw (2006) and consisted of six items rated on a 4-point scale ($\alpha = .49$). In order to improve reliability on the curricular autonomy scale, two items (item #1 and item #2) were removed, resulting in a four-item scale with a Cronbach’s alpha of 0.66 (see Question # 28 in Appendix A).

Interview. An in-person interview protocol was created to provide more in-depth descriptions of teachers’ decisions through the phases of the proposed decision-making process (motivation, discovery, evaluation, and preparation/adaptation). The interview was designed to take approximately 40 minutes, and consisted of four main sections: general discussion of the provided curriculum, general discussion of decisions regarding outside materials, discussion of specific outside materials (and comparison to provided materials), and personal views of high-quality math teaching. These final questions on teachers’ personal views of math teaching provided additional insight into teachers and their goals for math teaching that may not have been revealed by a focus solely on teachers’ curricular decisions.

Semi-structured protocol. Interviews followed a semi-structured protocol in order to ensure that similar content was covered in each interview, however interviews did tend to vary depending on the amount of background information teachers needed to provide in order to explain their decisions (e.g., explaining how students from multiple different home classrooms come together for math instruction), and the number of specific materials they wanted to share and discuss. Interviews were audio-recorded, and notes were also taken during the interviews to aid later transcription. The protocol also included several written responses designed to anchor the general discussion (see Questions #4, #8, and #9 in Appendix B).

Materials in interview. During the interview, teachers were asked to identify specific outside curricular materials they had considered using in the previous year, and to discuss why they were motivated to consider the materials, how they discovered the materials, how they evaluated the materials, and how they prepared and/or adapted the materials to use them in their classroom. Teachers were also asked to identify any relevant lessons or features of the provided materials that may have prompted them to consider outside materials. For example, a teacher

⁴ This scale was adapted to adjust language for an audience of teachers in the U.S. based on pilot feedback; specifically the term “pupil” was changed to “student,” and the prompt “How efficacious do you feel to perform the following?” (with anchors from *Not at all* to *Very much*, C. Charalambous, personal communication, May 10, 2015) was changed to “How well do you feel you can perform the following when teaching mathematics this year?” (with anchors from *Not at all* to *Very well*).

⁵ This scale was adapted to narrow the focus specifically to math teaching by adding the word “mathematics” (e.g., “In my teaching, I use my own guidelines and procedures” was changed to “In my mathematics teaching, I use my own guidelines and procedures”).

who wanted to engage in more whole-class open-ended math discussions identified the feature of the provided curriculum called “Math Talk,” discussed why she was often unsatisfied with the suggestions, and discussed why an outside material better suited her goals. These materials were shared electronically by teachers, photographed by the interviewer, or screen captured from a virtual sample of the provided curriculum.

Background data on schools. In order to contextualize interview responses and to engage in cross-school comparisons, historical and demographic data on the focal interview district and its focal interview schools were retrieved from publically available sources. Additional information about the context of the districts’ math curriculum and instruction efforts was gained through conversations with district curriculum specialists.

Procedures

District selection. Districts were initially screened based on size (having at least three elementary schools) and location (within Western Washington). After reaching out to curriculum and research departments, research proposals were sent to districts that had a clear research review process and/or interested members of the curriculum and instruction department. Several districts declined to approve the study, primarily out of concern for teachers’ limited time, and the potential for additional research surveys to interfere with participation rates of internal district and school surveys. Two districts that vary in size, location, and demographics granted approval of this research, and are hereafter referred to as Westbluff and Glencrest.⁶

Survey recruitment and data collection. Teachers of grades K-5 in participating districts were invited to participate in the online survey via an email invitation (either sent from the investigator or forwarded by a district administrator). Invitations were sent to teachers in the Westbluff and Glencrest districts within the last three weeks of the school year (June 2016). Teachers who completed a survey were entered into a drawing to receive one of fourteen gift cards, ten for \$15 and four for \$50, (two separate and identical drawings were held for each wave of data collection).

Interview recruitment and data collection. The Glencrest School District was chosen as the focal district for interviews due to its considerably larger size (which was more likely to afford multiple interviewees within a single school) and the fact that teachers had been provided with the same math curriculum package for several years at that point (Math Expressions, with the Common Core update provided for the past two years). After the first week and a half of survey data collection, existing survey responses were used to identify focus schools from within the Glencrest School District that had several (four to five) teachers who reported frequently considering outside materials (multiple times per week or more). Three schools were identified, here referred to as Brockway Elementary, Ogdenville Academy, and North Haverbrook Prep. In order to ensure a sufficient number of interviews, interview invitations were sent to all teachers at each of these schools who regularly (rather than frequently) considered using outside mathematics materials (at least one to two times per month).⁷ Interviews were conducted with four teachers at Brockway (six invited), three teachers at Ogdenville (seven invited), and two teachers at North Haverbrook (eight invited). Teachers received \$50 for participating in the interview.

⁶ Pseudonyms are used for all districts, schools, and teachers.

⁷ Expanding the invitation criteria from “multiple times per week or more” to “once or twice per month or more” allowed for an additional seven invitations. Two out of three “once per week” respondents completed interviews, while none of the four “once or twice per month” respondents elected to participate in an interview.

Data Collection Sites⁸

Survey data collection sites. Although the Westbluff and Glencrest School Districts are located within a similar geographical area, they differ from each other with regards to district size, student demographics, and math achievement. The Westbluff District is somewhat removed from major metropolitan areas, has a lower population density, lower college education levels, and has a much higher poverty level compared to Glencrest. The Glencrest District lies in an affluent and highly educated area, has few low-income students, and has higher mathematics achievement scores than the state average. See

Table 1 for additional details on the districts.

Table 1

District Comparisons

	Westbluff	Glencrest
Area	<ul style="list-style-type: none"> • low population density (<1500 persons per square mile) • near military base • moderate per capita income (bottom third in state) • low percentage of population with 4+ year college degree (just over half state average) 	<ul style="list-style-type: none"> • populous area (>4000 persons per square mile) • upscale shopping districts • high per capita income (top 20% in state) • high percentage with 4+ year college degree (double state average)
District Size	• small (<10 elementary schools)	• large (>15 elementary schools)
Student Racial Distributions	• largely similar to state averages; majority White, half the state average of Asian students	• plurality White, 4x more Asian students than state average, few Black students
Math Test Scores (3 rd -5 th 2015) ⁹	• notably below state average for 4 th and 5 th grades (similar for 3 rd)	• much higher than state average (50% more in 3 rd - 5 th grades)
Provided Materials	<ul style="list-style-type: none"> • Eureka Math <ul style="list-style-type: none"> ○ 1st year of piloting 	<ul style="list-style-type: none"> • Math Expressions <ul style="list-style-type: none"> ○ 2nd year w/ CCSS update
Low-Income	• majority of students (50% more than state average)	• few students (less than half state average)
ELL	• few students (half state average)	• similar to state average
Special Education	• slightly higher than state average	• notably lower than state average

Each district provided different curricular materials to their K-5 teachers for use during the 2015-2016 school year. As a part of their curriculum adoption process, the Westbluff School District piloted the Eureka Math curriculum (published by Great Minds, an education non-

⁸ Data on each district's locale were collected from recently available census data (2010 through 2014) at www.census.gov. Data on districts and schools were collected from the state's K-12 education department, the Office of Superintendent of Public Instruction, at <http://reportcard.ospi.k12.wa.us>. Each school's neighborhood characteristics were identified by visiting each school and examining online maps.

⁹ Statewide standardized testing (using the Smarter Balanced assessment) begins in 3rd grade.

profit). The Glencrest School District has been using Math Expressions (published by Houghton Mifflin Harcourt) since the 2008-2009 school year and has been using an updated Common Core version since the 2014-2015 school year.

Interview data collection sites. The three schools chosen as sites for interview data collection are all within the Glencrest School District, and thus share a geographical setting (affluent for the wider region) and provided curriculum (Math Expressions, Common Core Version). However each school differs from each other notably with regards to student demographics and math achievement. North Haverbrook Prep is one of the largest schools in the district (over 600 students), with higher than average math achievement and significantly lower than average percentage of students classified as low-income and Special Education. Ogdenville and Brockway are both on the smaller size in the district, with less than 500 students each. Ogdenville Academy is similar to the district averages on a range of characteristics. As a Title 1 school with a history of low academic achievement, Brockway Elementary is one of the few schools in the district that was designated as a “Public School Choice” school in the 2015-2016 school year. This means that families living within its boundaries were eligible to apply to have their student attend another school (with priority given to low-income and low-achieving students). See

Table 2 below for additional details on the interview school sites.

Table 2

Interview-Site Comparisons (Schools Within the Glencrest School District)

	North Haverbrook Prep	Ogdenville Academy	Brockway Elementary
Neighborhood	<ul style="list-style-type: none"> •residential •single-family homes 	<ul style="list-style-type: none"> •residential •single-family homes 	<ul style="list-style-type: none"> •residential with some commercial •apartments and single-family homes
School Size	<ul style="list-style-type: none"> •large (notably higher than district average) 	<ul style="list-style-type: none"> •medium (similar to district average) 	<ul style="list-style-type: none"> •medium (similar to district average)
Student Racial Distributions	<ul style="list-style-type: none"> •majority Asian; fewer White students and far fewer Latino students than district averages 	<ul style="list-style-type: none"> •plurality White; roughly similar distribution to district averages 	<ul style="list-style-type: none"> •plurality Asian; 3x more Latino students than district average, one-fourth the district average of White students
Title 1/Public School Choice	<ul style="list-style-type: none"> •No 	<ul style="list-style-type: none"> •No 	<ul style="list-style-type: none"> •Yes; parents can choose a higher performing school
Math Test Scores (3 rd -5 th 2015)	<ul style="list-style-type: none"> •notably higher than district average 	<ul style="list-style-type: none"> •slightly lower than district average 	<ul style="list-style-type: none"> •notably lower than district average (similar to state average)
Percent of students classified as:			
Low-Income	<ul style="list-style-type: none"> •half of district average 	<ul style="list-style-type: none"> •similar to district average 	<ul style="list-style-type: none"> •majority; 2.5x district average
ELL	<ul style="list-style-type: none"> •slightly higher than district average 	<ul style="list-style-type: none"> •similar to district average 	<ul style="list-style-type: none"> •majority; 5x district average

Special Education	• one-third of district average	• slightly lower than district average	• slightly lower than district average
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Approach to Analyses

Approach to survey analysis. Survey data was downloaded from Qualtrics into Microsoft Excel. Participants who did not meet inclusion criteria (described above) were removed. Participants were de-identified by replacing identifying information with ID codes for each participant, district, and school. Excel was used to calculate descriptive statistics and to examine themes in the handful of free-response items. Stata was used in order to calculate inferential statistics (e.g., *t*-tests, chi-square tests of independence, Spearman’s rank correlation, multiple linear regression). In all cases, a *p*-value equal to or less than 0.05 was considered statistically significant.

First, I used nonparametric statistical analyses to study the differences between teachers in each district. Nonparametric analyses were used rather than more conventional *t*-tests because the data are not normally distributed, and thus *t*-tests may overstate the differences between groups and result in false positives. Instead, in order to establish equivalence of the two districts on teacher demographic variables,¹⁰ Mann-Whitney and chi-square tests¹¹ were used to relax the normality assumption of conventional *t*-tests. A Mann-Whitney test was also used to investigate differences between districts in the frequency with which teachers considered using outside materials. Effect size for significant Mann-Whitney tests was computed and interpreted as described by Fritz, Morris, and Richler (2012).

Kruskal-Wallis test was used to establish the equivalence of teachers’ years of teaching experience (which was not normally distributed) across grade levels, to relax the normality assumption of the more conventional ANOVA.

Chi-square analyses were used to compare whether the distribution of categorical variables differed by district. In all chi-square analyses in which the expected frequency of any cell was less than five, the more conservative Fisher’s exact test was used because chi-square tests yield *p*-values that are too low under small sample conditions (Agresti, 1992).

A Spearman’s rank-order correlation was used to examine the relationship between teachers’ ratings of the efficacy of their provided materials (an ordinal variable with only three categories) with the frequency with which they considered outside materials.

Multiple linear regression was used to examine the personal and contextual factors that may predict teachers’ motivation to consider outside materials. Teachers’ reported frequency of considering outside materials was the outcome variable. Model covariates include: age, current grade level (which was dummy coded), years of experience as a K-5 teacher, years of experience at current grade level, years of experience at current school, years of experience with the provided curriculum, feelings of self-efficacy for teaching math, and feelings of curricular autonomy for teaching math. Because teachers’ frequency of considering outside materials was skewed towards more frequent consideration, a tobit regression that relaxed the assumption of normality was fit to the data. The results from the tobit model were compared with the results from the conventional linear model. The coefficients, standard errors, *p*-values, and fit from the

¹⁰ These variables were non-normal: each years of experience variable skewed towards less experience (with current grade, at current school, with provided curriculum, and as a K-5 teacher) across districts, while age skewed higher in Westbluff.

¹¹ Mann-Whitney tests were used for interval variables, and a chi-square test was used for the categorical demographic (current grade level).

tobit model and the linear model were nearly identical. Therefore, the more conventional linear model was selected as the final model for this analysis.

Approach to interview analysis. Interviews were audio recorded, content-logged with timestamps, and coded using Dedoose software. Dedoose allows for segmentation of content-logs into excerpts, which can then be assigned codes; next, all excerpts from within or across interviews with a given code can be exported for further analysis. Initial codes were developed to reflect the framework and content of the interview; thus there were codes for discussion pertaining to the provided curriculum (specific and general), to outside materials (specific and general), and to each phase of the decision process regarding outside materials (“Consider,” “Discover,” “Evaluate,” and “Prepare/Adapt”). Subordinate codes for each phase of the decision process were used to add more detailed descriptions, including reasons for considering outside materials, effective approaches for discovering outside materials, influential evaluation criteria, and common reasons for adaptations. Additional content codes were used to describe other aspects of the content of teachers’ responses, including comments about the students’ identities, the participants’ own identities as teachers or math learners, comments regarding constraints or affordances of their school or district contexts, and comments regarding their professional goals as teachers. See Appendix C for an illustrative but not exhaustive list of codes. As interviews were being coded, additional codes were added when content emerged that could not be easily captured by existing codes (e.g., a teacher described a new curricular characteristic: “boring”). At each addition of a new code, previously coded interviews were reviewed to ensure that all codes were consistently applied across interviews.

Text from content logs was coded into excerpts that varied in length, but that could be described with a single set of codes. For example, most excerpts in a lengthy discussion following a question regarding the weaknesses of the provided curriculum would be coded as “provided material (general),” and most would also be coded with “Con (weakness/negative evaluation),” but the lengthy discussion would be broken down into shorter excerpts based on specific content (e.g., the excerpt “Math Expressions tends to include a whole lot of worksheets, and the suggestions for whole-class discussion aren’t very meaty, but that’s where a lot of learning happens,” would be coded with “provided material (general),” “Con (weakness/negative evaluation),” “worksheet,” “discussion prompt,” and “views of how students learn math.”). Statements that diverged from the general topic of describing weaknesses of the general curriculum would be contained within their own excerpts with appropriate codes (e.g., the excerpt “That’s why I love using *Number Talks*, it helps us get deep into the mathematical reasoning and discussing,” would be coded with “outside material (general),” “Number Talk,” “Pro (strength/positive evaluation),” and “supports rich mathematical discussions”). Occasionally, excerpts were much longer than the examples above when teachers made multiple comments that could all be captured by a single set of codes.

After all interviews were coded, they were analyzed using multiple rounds of a process that included filtering, exporting, condensing, and summarizing. First, excerpts were filtered by codes for each step in decision process (outlined in the research framework on page 6): “consider,” “discover,” “evaluate,”¹² and “prepare/adapt.” These excerpts were then exported

¹² For the “evaluate” step, the set of excerpts with the “evaluate” code was additionally reduced to include only those in which a participant identified that they were discussing a curricular characteristic that would *most* influence them to use the material (indicated by the code “most influential”), or a characteristic that they specifically look for (code: “look for”), or a characteristic that they specifically avoid (code: “avoid”).

into Microsoft Excel and condensed to portions relevant to that code by deleting extraneous comments (note: each excerpt retained all codes that had been applied to it). Brief descriptive summaries were then written for excerpts, in order to succinctly capture the nature of teachers' comments. Summaries for each participant were then written to capture the variety of comments they made on a given phase of the decision process, and these summaries were then compared across participants to reveal cross-participant themes in responses. Subsequent rounds of this analysis process included filtering by other codes such as "institutional contexts (school-level)," "views of how students learn math," and "district expectations around use of provided materials" to focus on how teachers described each of these topics.

Roadmap for Organization of Results

This investigation employs a large online survey and in-person interviews in order to allow for some level of both breadth and depth in the data that is used to examine teachers' decisions around outside curricular materials in mathematics. The list below includes each research question, and describes how various sources of evidence will be used to address it:

1. What motivates teachers to consider outside materials? And how prevalent/frequent is the consideration of outside materials?
 - Survey data describe the percentage of teachers overall and in each district and school who reported considering outside materials. Survey data also describe how frequently teachers considered using outside materials and the most commonly cited reasons that motivated their consideration. For teachers who report that they did not consider using outside materials, data reveal commonly cited reasons for staying with the provided materials.
 - Interview responses provide additional information on how focal teachers describe their decision process and the situations in which they are motivated to consider using outside materials.
 - Specific provided curricular materials that teachers presented during interviews are examined both for characteristics that support teachers' descriptions of the limitations of the provided materials that spur consideration of outside materials, as well as characteristics that challenge teachers' descriptions. Discussion of the ways in which specific outside materials improve upon the provided materials helps to reveal additional reasons for considering outside materials.
2. Where and how do teachers discover these materials? And which discovery approaches do they find most useful?
 - Survey data describe frequently used approaches to discovering outside materials, as well as reasons why these discovery approaches are preferred.
 - Interview responses provide additional information regarding how focal teachers decide to search for an outside material rather than adapt provided materials or create new materials from scratch.
3. What characteristics are important to teachers as they evaluate potential outside materials? (e.g., cost, ease of acquisition)
 - Interview responses reveal questions that focal teachers ask as they evaluate outside materials, as well as specific characteristics that are highly influential on their decision to use an outside material.
 - Specific outside curricular materials that teachers presented during interviews are examined in order to describe the extent to which they meet teachers' stated criteria.

4. How do teachers prepare or adapt outside materials before using them in their classrooms?
 - Interview responses describe the steps focal teachers take in order to use specific outside materials in their classroom.
 - Specific outside curricular materials that teachers presented during interviews are used to illustrate any adaptations and at times reveal additional teaching goals.
5. How do personal and contextual factors that are external to materials (e.g., teachers' years of experience with a curriculum, perceptions of curricular autonomy, or self-efficacy for teaching math) relate to teachers' decisions to use outside materials?
 - Survey data are analyzed using inferential statistics in order to determine whether patterns in consideration and discovery of outside materials differ by context or teacher characteristics.
 - Interview responses are analyzed for content that suggests the influence of personal factors (e.g., teachers' views of math teaching) or contextual factors (e.g., teachers' grade level teams) that may relate to teachers' decisions regarding outside curricular materials.

Analysis of survey data is used to address research questions 1, 2, and 5, and is presented in Chapter 3. Analysis of interview data is presented in Chapter 4, and although it is primarily used to address research questions 3 and 4, the interview was also designed to shed light on all research questions. In Chapter 5, the interview responses of three focal teachers are presented alongside images of their specific provided and outside curricular materials in order to elaborate findings from the interviews, ground findings in specific examples, illustrate a variety of decisions and outside materials. In Chapter 6, results from all data sources are synthesized to provide an overall view of the decision process around outside curricular materials and support a discussion of implications.

Chapter 3: Results of Survey

Overview

Questions in the online survey were designed to focus on the first two phases of the proposed decision process: motivation to consider outside materials and discovery of outside materials. The survey also provided data on several personal and contextual factors that may influence teachers' decisions. In this chapter I describe the participant sample, reveal the frequency with which teachers considered using outside materials, explore reasons why teachers were motivated to consider outside materials, and describe common approaches to discovering outside materials. I also examine personal and contextual factors that may relate to teachers' motivation to consider outside materials, including their teachers' years of experience with the provided materials and their feelings of curricular autonomy.

Description of Survey Participants

The 98 survey participants included in the final sample include 20 teachers from the Westbluff District and 78 teachers from the Glencrest District.¹³ Participants cover a range of grades (between kindergarten and grade 5) and years of teaching experience, as shown in Table 3 (a Kruskal-Wallis test revealed no statistically significant differences between grade levels in years of K-5 teaching experience, $\chi^2(6) = 3.93$, $p = 0.69$).

Table 3

Teachers' Years of K-5 Teaching Experience by Grade Level Taught in 2015-2016

	K	1	2	3	4	5	multiple
n	12	15	15	19	16	16	5
M	11.6	10.8	10.2	9.3	10.9	12.1	8.6
SD	9.4	9.8	9.3	8.4	6.8	5.4	7

In order to establish that teachers in each district did not differ on potentially important demographic characteristics, district comparisons were made for teachers' age, grade level taught in the 2015-2016 school year, years of experience at that grade level, years of experience at their school, years of K-5 teaching experience, and years of experience with the provided curriculum. There were no statistically significant differences between districts in the number of teachers at each grade level, $p = 0.26$ (Fisher's exact test). No statistically significant differences were found between districts with regards to each of these demographic variables with the exception of years of experience with the provided curriculum, see Table 4 for details. Teachers in Glencrest had significantly more years of experience with their provided curriculum. Because teachers in Westbluff were piloting a new curriculum, all participants reported having only 1-3 years of experience with their provided materials, with a mean of 1.7 and a standard deviation of 0.57 (teachers who reported 2 to 3 years of experience are presumed to be part of smaller pilot groups during earlier school years). Teachers in Glencrest reported as many as 11 years of experience with the provided materials, with a mean of 4.7 years, and a standard deviation of 2.5 years.¹⁴

¹³ The sample includes four teachers (two from each district) who identified themselves as special education teachers and reported that they were provided with the same curricular materials as all other teachers.

¹⁴ Note: Caution should be used when interpreting Glencrest teachers' years of experience with the provided curriculum. Validity of these responses are complicated by the fact that some teachers may have reported their experience with the specific edition of the curriculum (the Common Core update of Math Expressions, adopted in

Table 4
Sample Demographics and District Demographic Comparisons

	Overall Sample				District Comparisons			
	<i>M</i>	<i>SD</i>	min	max	<i>z</i>	<i>p</i>	Westbluff median	Glencrest median
Age ¹⁵	40.6	11.0	23	63	0.83	0.41	41	39
Years at current grade level	6.4	6.9	1	34	-0.74	0.46	3	4
Years at current school	7.2	6.2	1	28	-1.08	0.28	4	5.5
Years of K-5 teaching experience	10.6	8.0	1	35	-0.48	0.63	7	9
Years with provided curriculum	4.1	2.6	1	11	-5.24	<0.01	2	5

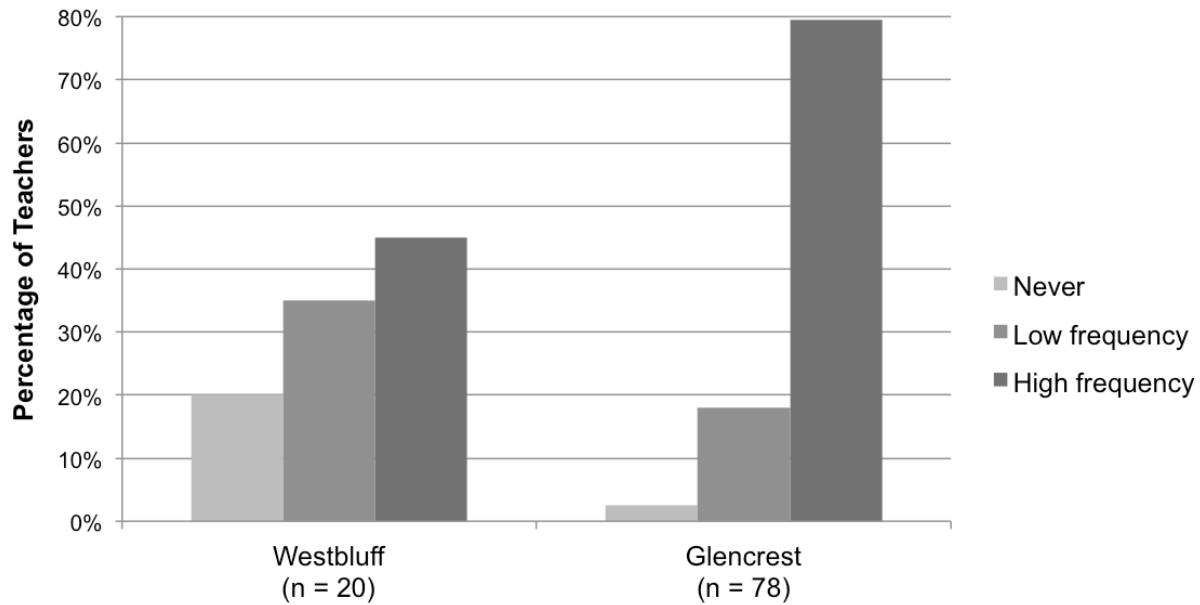
Teachers' Consideration of Outside Materials

Two of the fundamental questions addressed by this study are “How many teachers considered using outside materials?” and “How frequently did they do so?” Teachers were first asked if they ever considered using an outside material in past year, and if so, how frequently they did so (choosing from six frequency categories, see Question #19 in Appendix A). In the sample reported here, 93.9% of participants reported that they considered using an outside material at least once in the 2015-2016 school year. Among the teachers who did consider using an outside material, they did so frequently; a majority of all teachers (72%) considered outside materials at least once a week, and a good portion of those respondents (52% of all teachers) considered outside materials even more frequently.

The trend towards considering outside materials was stronger among teachers in Glencrest (97% considered an outside material) than in Westbluff (only 80% considered an outside material). A Mann-Whitney test revealed that this trend was statistically significant, $z = -2.53$, $p = 0.01$, with a moderate effect size, $r = 0.25$. The median frequency of considering outside materials among Westbluff teachers was “once or twice per month” while the median frequency among Glencrest teachers was “multiple times per week.” In order to better visualize the differences between districts teachers’ reports of how frequently they considered using outside materials were collapsed into three categories: never, low frequency (one to two times per month or less), or high frequency (around once a week or more), see *Figure 3*. Reasons for these differences between districts will be explored in the following section on teachers’ motivation to consider outside materials.

2014-2015), while other teachers reported their total experience with the Math Expressions curriculum (both before and after the update). If a number of teachers did report their years of experience with the recently updated version, this would under-estimate their total years of experience with the curriculum, thus the finding that Glencrest teachers have more experience with their provided materials than Westbluff teachers would still hold.

¹⁵ Although there was no statistically significant difference between districts with regards to participant age, participants from Westbluff did skew somewhat older than those from Glencrest (30% of participants over age 55 in Westbluff, compared to 9% of participants over age 55 in Glencrest).



Teachers' Consideration of Outside Materials

Figure 3. Frequency of considering outside materials by district.

Teachers' Motivation to Consider Outside Materials

In this section, I consider potential reasons why some teachers are motivated to frequently consider outside materials while others are not. This will include exploring the features of the provided materials teachers would most like to change, and examining the hypothesis that teachers who consider outside materials frequently are more dissatisfied with their provided materials than those who rarely or never consider outside materials. Specifically, frequent-considerers are hypothesized to rate their provided materials as less effective in helping them reach their goals. In order to better understand the conditions under which teachers are or are not motivated to consider outside materials, I also analyze the specific reasons that motivated teachers' decisions to consider or to not consider outside materials. By examining patterns in these four components of the online survey: teachers' ratings of effectiveness of their provided materials, features that teachers wish to change in their provided materials, reasons why some teachers did not consider outside materials, and reasons why many teachers did consider using outside materials, we can gain insight into this understudied initial phase of the decision process around outside materials.

Teachers' ratings of the effectiveness of provided materials. In order to examine the hypothesis that teachers are motivated to consider outside materials due to dissatisfaction with their provided materials, I explore teachers' provided materials ratings (one component of satisfaction). Teachers were asked to respond to the following question: "How effective is the provided curriculum in supporting you in meeting your teaching goals?" Respondents used a four-point Likert scale (1 = *not effective at all*, 2 = *not very effective*, 3 = *somewhat effective*, 4 = *very effective*). Overall, teachers reported being satisfied with their materials, with a stronger trend towards high satisfaction than low satisfaction: most teachers (52%) reported that the provided materials were "somewhat effective," many teachers (41%) reported that the provided materials were "very effective," and no teachers reported that their provided materials were "not effective at all." Comparing the provided materials ratings of teachers who considered outside

materials never or rarely to those who considered outside materials frequently provides some support for the hypothesis that less satisfaction with provided materials is related to higher frequency of considering outside materials. As shown in *Figure 4* below, the general trend towards high effectiveness ratings was stronger among teachers who reported never considering outside materials, and among teachers who reported a low frequency of considering outside materials (one to two times per month or less). Most of these teachers reported that the provided materials were “very effective” (100% of those who never considered outside materials, and 57% of those who infrequently considered outside materials). The hypothesis that satisfaction with provided materials is inversely related to frequency of considering outside materials is further supported by the results of a Spearman’s correlation, which revealed a moderate negative correlation between provided-curriculum-effectiveness and frequency of considering outside materials, $r_s = -0.338, p < 0.001$. The fact that all six of the teachers who rated their provided materials as “very effective” suggests that although evaluating provided materials as highly effective does not guarantee that a teacher will use only provided materials, it may be an important component of this decision. However, the small number of teachers in this group calls for cautious interpretation of this result.

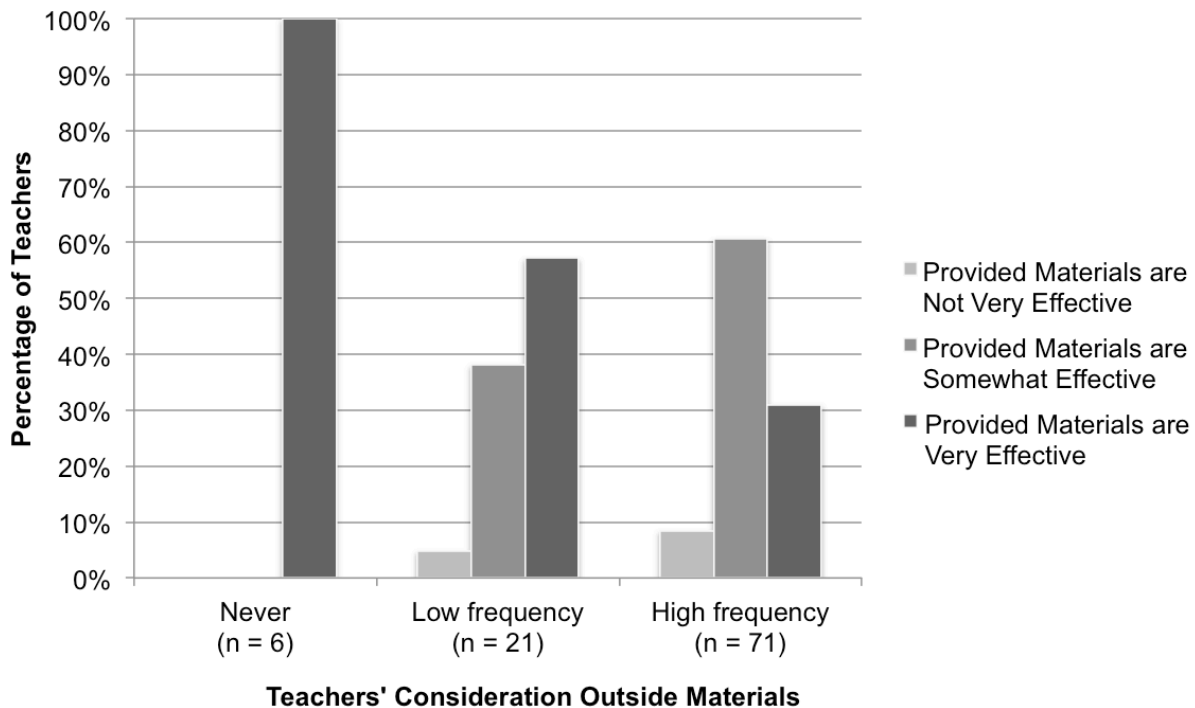


Figure 4. Teachers’ ratings of the effectiveness of their provided materials by frequency of considering outside materials.

Returning to the earlier finding that Westbluff teachers considered using outside materials less frequently than Glencrest teachers, I hypothesized that this may have been due to Westbluff teachers rating their provided materials as more effective. Although Westbluff teachers did trend towards more positive effectiveness ratings (mean rating of 3.55 on 4-pt scale) than Glencrest teachers (mean rating of 3.28 on 4-pt scale), Fisher’s exact test revealed that this difference was non-significant, $p = 0.13$. Despite the fact that no significant difference was found between districts in teachers’ ratings of their provided materials, it is possible that there

are differences in the underlying reasons for their ratings that could help to explain why teachers in Westbluff considered outside materials less frequently. Although teachers were not asked to list specific reasons for being satisfied with their provided materials, they were asked what they would change about their provided materials. This provides an opportunity to examine district-level differences in underlying reasons for *dis*-satisfaction with provided materials, which I explore in the following section.

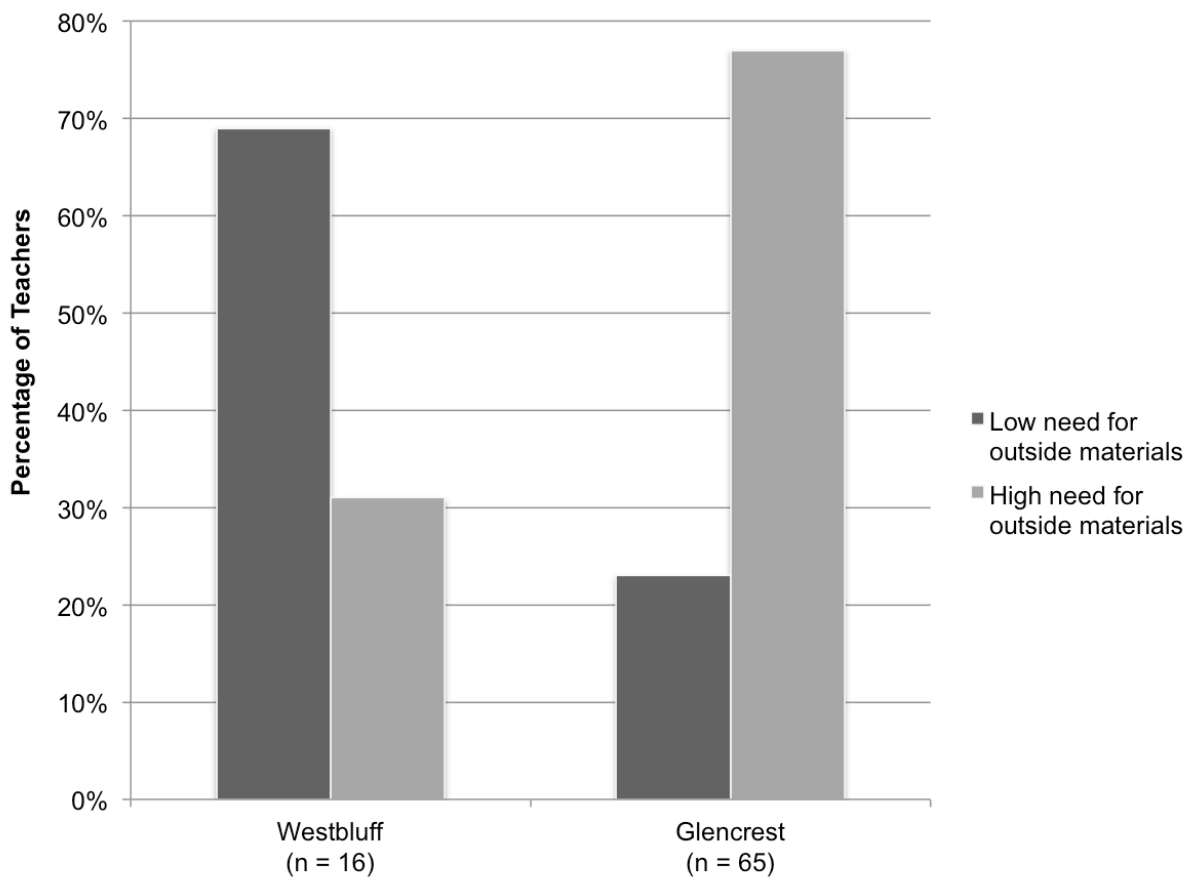
Features of the provided materials teachers would change. When asked what one thing they would change about their provided curriculum, teachers' open-ended responses indicated a variety of specific reasons for dissatisfaction. These "things teachers would change" can also be interpreted as "teachers' identified needs with regard to the provided materials." The most common response from teachers (19% of respondents) was that they would add more opportunities to differentiate instruction to various student skill levels, with a particular focus on challenging activities for highly skilled students. Another large group of respondents (16%) described a need for more hands-on activities and games, with a notable portion specifically mentioning project-based learning. The next most common response was that teachers would add more practice opportunities (9%), and contrastingly, a similar number of teachers reported that they would shift the focus away from procedures and towards opportunities for reasoning and discovery (8%). For example, one teacher responded that the one thing they would change about their provided materials is, "more conceptual exploration of concepts—time for kids to 'discover' concepts rather than constant direct instruction."

Relationship between identified needs and motivation to consider outside materials. Each of these "identified needs" that were commonly endorsed illustrate why teachers were likely to be motivated to consider outside materials: they needed outside materials to meet these needs. These needs—differentiating for various skill levels, providing hands-on activities, providing more practice, and providing more discovery opportunities—are difficult to meet by simply omitting or re-arranging parts of the provided materials. Instead, these needs call for additional types of activities. Thus, teachers who reported these types of needs may have stronger motivation to incorporate outside materials (either created themselves or discovered from other sources). This raises two questions: first, did teachers report other types of needs that indicate lower motivation to consider outside materials? Second, do patterns in these two types of identified needs differ by district, offering some explanation as to why Glencrest teachers considered outside materials more frequently than Westbluff teachers?

After establishing that certain identified needs suggest a high motivation to consider outside materials, the first task was to determine whether there were other identified needs that suggest a low motivation to consider outside materials. In order to do this, I examined all responses regarding the one thing teachers would change about their provided curriculum and coded responses into two categories: "indicates high need for outside materials" (described above) and "indicates low need for outside materials." Identified needs were coded into the "low" category when they did not have clear links to a need for outside materials, but instead represented needs that could be met with other types of curricular adaptations such as omitting or rearranging aspects of the provided materials (e.g., "reduce breadth"), or delivering the materials in another format (e.g., "teach more in small groups"). These teachers who identified that they would slow down the pacing or reduce the number of strategies presented for a particular concept are hypothesized to be less motivated to incorporate outside materials, because their goals can be met with other, potentially less time-intensive, adaptations. In order to confirm that these two categories do indeed align with differences in motivation to consider outside materials,

an independent samples *t*-test using Satterthwaite’s approximation for unequal variances was used to compare teachers’ frequency of considering outside materials in each of these groups. Teachers in the “high need for outside materials” considered outside materials significantly more often ($M = 4.58, SD = 1.1$) than teachers in the “low need for outside materials” group ($M = 3.27, SD = 2.07$), $t(31.9) = -3.04, p = 0.005$.

District differences in identified needs. After confirming that teachers’ identified needs regarding their provided materials are linked to their frequency of considering outside materials, the second question I examined was whether or not there was a difference between districts in teachers’ identified needs. It was hypothesized that Westbluff teachers would be more likely to report changes to their provided materials that indicate a low need for outside materials, because this would provide one potential explanation for why Westbluff teachers considered outside materials less frequently than Glencrest teachers. A chi-square test of independence was used to compare whether teachers in each district reported similar types of changes to their provided materials. A statistically significant difference between districts was found, $\chi^2(1) = 12.29, p < 0.0001$, such that Westbluff teachers were 7.33 times more likely to cite changes to the provided curriculum that indicate lower motivation for outside materials (e.g., changes to pacing or breadth, and suggestions on how to manage and prepare the materials). As shown in *Figure 5* below, the desired changes of most teachers in Glencrest (77%) suggested a high motivation to consider outside materials (e.g., different types of activities), while only 31% of Westbluff teachers cited those types of changes.



Teachers' Identified Needs Regarding Their Provided Materials

Figure 5. Teachers’ identified needs regarding their provided materials by district.

Potential reason for district differences in identified needs. One reason for this difference between districts is likely the number of years the district has been providing their curriculum. In Glencrest, which has been providing their curriculum for many years, the district math team regularly re-configures the pacing guide (including the number and order of units/lessons) based on teacher feedback. Westbluff was piloting a relatively new curriculum that they had only been provided with for one or two years, which has given the district less of an opportunity to try out different pacing and ordering, and to troubleshoot issues of materials and preparation (common needs identified by Westbluff teachers). This suggests that teachers in Glencrest may have considered using outside materials more frequently because their pacing and support for implementation was adequate (leaving opportunity to fine-tune activities, which were the focus of Glencrest teachers' identified needs), or that teachers in Westbluff were less likely to consider using outside materials because their activities were adequate (leaving opportunity to fine-tune pacing and materials management, the focus of Westbluff teachers' identified needs). It is also possible that both of these dynamics could operate at the same time. Additional research is warranted to confirm and clarify these patterns, and to investigate whether there is a natural progression when provided with a new curriculum to begin with issues of pacing and materials management, and move to issues of activity type, engagement, and rigor.

Reasons why some teachers did not consider using outside materials. Only six teachers reported that they did not consider using outside materials in the 2015-2016 school year. Among these teachers, the most frequently endorsed reason for not considering outside materials was that "the provided curriculum is well-aligned with my students' needs." No teachers reported that their main reason for using only provided materials was that their district administration, school administration, or teacher colleagues "strongly frown upon adaptation," suggesting that these outside pressures either do not exist for these participants, or that they are not influential. Although this subgroup of teachers is very small and additional research is needed, these responses suggest that teachers who eschew outside materials do so because the provided curriculum is meeting their needs, rather than specific outside pressures to stay aligned. This provides some support for the hypothesis that teachers are motivated to consider outside materials when they regard their provided materials as unsatisfactory.

Reasons why many teachers did consider using outside materials. As reported above, the vast majority of teachers (93.9%) considered using outside materials at least once during the 2015-2016 school year, and many of those teachers did so frequently. In order to better understand teachers' motivation for considering outside materials, participants were given seven potential reasons for considering an outside material (reasons were identified through piloting) and asked to rate how frequently each reason motivated their consideration on a 5-point scale (0 = *never for this reason*, 1 = *rarely for this reason*, 2 = *sometimes for this reason*, 3 = *often for this reason*, and 4 = *almost always for this reason*). Teachers were also asked to pick which single reason was the most important or frequent motivator behind their decision to consider outside materials (referred to here as the "main reason"). Teachers' responses reveal that they frequently considered outside materials in order to provide extra review or extra challenge, as well as to provide activities that would be more engaging for students (responses shown in Table 5 below). These frequently-endorsed reasons for consideration (engagement, challenge, review) mirror teachers' open-ended responses regarding the thing they would most like to change about their provided materials: differentiation for different student skill-levels and more hands-on activities. This provides further support for the link between teachers' dissatisfaction with provided materials and their search for outside materials.

Table 5
Teachers' Reasons for Considering Outside Materials

	Main Reason for Consideration (% of all teachers)	“Often” or “Almost Always” a Reason for Consideration (% of all teachers)
Frequent Reasons for Consideration		
Provide a more engaging activity	30%	65%
Provide students with extra challenge	25%	76%
Provide students with extra review of concepts	18%	73%
Somewhat Frequent Reasons for Consideration		
Increase focus on mathematical concepts	9%	52%
Provide more practice with procedures	7%	54%
Provide students with more manipulatives	4%	33%
Infrequent Reasons for Consideration		
Reduce time to prepare lesson	0%	4%

Note. Percentages are lower in the left column than the right because when rating their “main reason for consideration” teachers were required to select a single reason, but when rating how frequently each reason motivated their consideration, teachers could rate multiple reasons as “often” or “almost always” a reason for consideration. Percentages in the left column do not total 100% because six teachers chose “other” as their main reason.

Relation between personal/contextual factors and teachers’ motivation. In addition to the central hypothesis that teachers consider using outside materials due to dissatisfaction with their provided materials, this study is designed to explore personal and contextual factors that may influence teachers’ decisions. Teachers who are new to teaching (or to a specific grade, school, or provided curriculum) may be less inclined to consider outside materials until they have had a chance to fully vet the provided materials. Similarly, teachers with lower self-efficacy for teaching math may feel less confident in their abilities to go beyond the provided materials that have been approved by their districts. Regardless of teachers familiarity or confidence with teaching their provided math materials, teachers who report low feelings of curricular autonomy may be less likely to consider outside materials due to constraints from their institutional context, whether it be district mandates, principal observations, or the practice of their teacher colleagues.

A multiple linear regression was used to test the statistical association between teachers’ frequency of considering outside materials and personal and contextual factors (Table 6). Specifically, factors of interest included teachers’ age, feelings of self-efficacy for teaching math, feelings of curricular autonomy in math, and their years of experience at their school, at their grade level, and as an elementary teacher. All years were self-reported by teachers, while measures of curricular autonomy in math and self-efficacy for teaching math were created from multi-item scales (see questions #28 and 29 in Appendix A for item wording, and Methods section for details on scale reliability). Below I describe two statistically significant patterns, and identify the variables that were not found to be predictive of teachers’ consideration of outside materials.

First, teachers' reported feelings of curricular autonomy for teaching math predicted higher frequency of considering outside materials ($t = 2.28, p = 0.025$), controlling for age, grade level, years with the provided curriculum, years at current grade level, years at current school, years as a K-5 teacher, and self-efficacy for teaching math. For every additional 1-point increase in teachers' ratings of their feelings of curricular autonomy (rated on a 4-point scale), the expected frequency of considering outside materials increased by 0.65 points. This suggests that teachers who reported more feelings of freedom regarding their curricular choices also demonstrated that freedom by using outside materials more frequently.

Second, teachers' additional years of experience with their provided curriculum also significantly predicted the frequency with which they considered outside materials ($t = 3.22, p = 0.002$), controlling for age, grade level, years at current grade level, years at current school, years as a K-5 teacher, curricular autonomy, and self-efficacy for teaching math. For every additional year of experience teachers had with the provided curriculum, their expected frequency of considering outside materials increased by an estimated 0.21 points. Put another way, for every additional five years of experience with the provided curriculum, teachers are predicted to have chosen the next higher category to describe the frequency with which they consider outside materials (e.g., from "around once a week" to "multiple times per week"). This suggests that as teachers gain experience with their provided materials, they gradually become more likely to incorporate outside materials, potentially because they have found what works and what does not work for their students.

Finally, after controlling for the remaining variables in the model, no relationship was found between teachers' frequency of considering outside materials and their grade level (dummy coded; $p > 0.20$ for each grade), age ($p = 0.17$), years of experience as a K-5 teacher ($p = 0.87$), years of experience at their grade level ($p = 0.98$), years of experience at their school ($p = 0.75$), or their feelings of self-efficacy for teaching math ($p = 0.83$).

Table 6

Multiple Regression Results Testing the Association Between Frequency of Considering Outside Materials and Teacher Variables

Variable	Coefficient	SE
Curricular Autonomy in Math	0.654*	(0.286)
Years with Provided Curriculum	0.211**	(0.066)
Age	-0.029	(0.021)
Years at Grade Level	-0.001	(0.033)
Years at School	0.011	(0.037)
Years as K-5 Teacher	-0.006	(0.039)
Self-efficacy for Teaching Math	0.030	(0.144)
Constant	2.864	(1.387)
R^2	0.228	
F	1.84	
N	95	

Note: * $p < 0.05$, ** $p < 0.01$

Before moving on, I consider a potential threat to the validity of the finding that more years of experience with the provided curriculum predicts teachers' frequency of considering outside materials. In the survey, teachers were asked to report both their years of experience at

their current school and their years of experience with the provided curriculum. In Glencrest, where the provided curriculum was adopted eight years ago, it was assumed that teachers who reported teaching at their school for eight or more years would also report at least eight years of experience with the provided materials. However, this was not the case. Most Glencrest teachers who reported eight or more years at their current school reported less than eight years of experience with the provided materials. There are three possible explanations for this unexpected pattern. First, the assumption that eight or more years at a school should equal eight or more years with the provided curriculum may be faulty. For example, some teachers may have taught at their school for eight or more years, but if they did not teach math for some of those years (e.g., in a rotation configuration in which they taught language arts and partnered with another teacher who taught math), they would report less than eight years of experience with the provided materials. Second, there may have been differences in how teachers interpreted the question about experience with provided materials. Although Glencrest adopted the Math Expressions curriculum eight years ago, the Common Core Update version began being provided two years ago (and was potentially piloted by some teachers as many as three years ago). Thus teachers who taught at their school for eight or more years, but reported only two to three years of experience with the provided curriculum, may have been specifically referring to the updated version of the materials. Third, teachers may have simply misremembered their years of experience (either at their school or with their provided materials). For example, a teacher may have recollected that the provided curriculum was adopted seven years ago rather than eight, or they may have incorrectly reported that they began at their school eight years ago rather than seven. These possible explanations raise some questions about exactly what teachers' reported years of experience with the curriculum represents, but they do not indicate a clear direction of measurement error. There is no reason to believe that differences in teachers' interpretations of the question or their errors in memory would relate to their frequency of considering outside materials, and thus raise alternate explanations for the finding that more experience with the provided materials predicts higher frequency of considering outside materials. Rather this variable may simply be limited by more random measurement error than was anticipated. Implications of the limitation of this variable will be discussed further in the discussion.

Teachers' Discovery of Outside Materials

In the second phase of the proposed framework, teachers who are motivated to consider outside materials use various discovery approaches to find materials that fit their needs. Teachers were asked to rate how frequently they used eleven different potential discovery approaches to find outside materials on a 5-point scale (0 = *never used this approach*, 1 = *rarely used this approach*, 2 = *sometimes used this approach*, 3 = *often used this approach*, and 4 = *almost always used this approach*). Teachers were also asked to identify their main discovery approach (the approach they used most frequently or found most useful), and to provide a brief open-ended explanation of why that approach was most useful. Because this is a new area of study, there are no specific hypotheses regarding which discovery approaches are used most often or reasons for using certain approaches, but rather these analyses offer a first exploration into this area.

Teachers' frequently used discovery approaches. Teachers' responses indicate that they used a wide variety of discovery approaches, and that some approaches were used more frequently than others (see Table 7). Teachers frequently searched through their own collection of curricular materials, browsed specific websites that they knew had relevant materials, asked

other teachers, and performed general online searches (e.g., Google). Other approaches included searching online in a specific forum (e.g., Pinterest or Facebook), asking a math specialist or coach, and happening to come across materials when talking with other teachers. Although teachers did “sometimes” find outside materials at events and via subscriptions, these approaches were rarely identified as a “main approach,” possibly because of the increased time and effort involved with attending events and/or the less targeted nature of coming across materials through these avenues. Four teachers added that they frequently created their own materials, with three of these teachers identifying this as their main approach for outside materials.

Table 7

Teachers’ Approaches Towards Discovering Outside Materials

	Main Approach (% of all teachers)	Approach used “Sometimes” or more (% of all teachers)
Frequently Used Approaches		
Searched own collection	20%	87%
Browsed a known website	18%	87%
Asked another teacher	14%	82%
Searched online using a generic search engine	13%	80%
Somewhat Frequently Used Approaches		
Searched online using another approach	14%	67%
Asked math specialist/coach	8%	40%
Came across when talking to teachers	7%	63%
Rarely Used Approaches		
Attended seminar/conference	1%	24%
Came across via a subscription	0%	28%
Came across at an event	2%	33%
Posted a request to a group online	0%	5%

Reasons for teachers’ main discovery approach. In order to better understand the affordances of these different discovery approaches, teachers’ open-ended responses regarding their “main” discovery approach were coded to identify themes in why these approaches were used so frequently. Here I explore frequently used approaches, beginning with a focus on offline-methods, and later moving to various online methods (summarized in Table 8 on page 36). Overall, trends across all discovery approaches suggest that teachers use techniques that are first and foremost: efficient. The speed with which relevant materials could be discovered was a dominant theme that motivated both online and offline discovery approaches.

Offline discovery approaches. Teachers used a variety of efficient and trustworthy offline approaches for discovering outside materials. Teachers who searched their own curricular collection did so primarily because of the convenience and efficiency of this method, noting that they have many materials that are readily accessible and that have been proven to be successful in their classroom. Several teachers also described the materials in their collection as fulfilling a particular goal or need, such as incorporating more engaging activities, more review, or more rigor. As one new teacher noted while referring to her graduate program, “I had great materials from the professors there that I love using. The materials increased the rigor and math

discussions in my classroom, which helps us construct knowledge together.” This suggests that one reason this was such a frequently-used approach is because teachers’ collections are aligned with their professional goals, that is teachers may retain materials that align with their goals, and discard materials that do not, resulting in a highly-relevant library. Colleagues were another frequent source of outside materials. Teachers who asked other teachers about outside materials valued their experience with the grade-level, and commented that the materials had already been proven to be useful (or as one teacher put it, they were “good practical ideas that have been ‘battle-tested’”). Teachers who came across materials when talking with other teachers cited similar reasons (trusting experienced teachers and proven materials), but added that this was an “organic” way to share information because collaboration was often already happening. Teachers whose main approach was to ask a district- or school-based math specialist reported that they did so because their specialist was very knowledgeable and helpful.

Online discovery approaches. Teachers who identified that their main approach involved the internet frequently cited the ease and efficiency of these approaches (e.g., “Required time to complete a Google search? Seconds. I use this approach because of how quick[ly] and instantly I can get results”). However beyond this general affordance of online approaches, specific themes emerged for the different types of online approaches that were outlined in the survey (i.e., conducting a broad search via a generic search engine, or conducting a narrow search on a specific site).

Teachers who reported that they most often used a generic search engine (such as Google or Bing), added that in addition to being efficient, this approach offered a large quantity and variety of resources, with several teachers alluding to the fact that this also exposed them to new and more updated ideas and materials. For example, one teacher found value in general searches because they bring up blogs with “more updated materials that people are currently using for their class.”

Teachers who most often searched or browsed on previously-identified websites reported that this was their main approach because it was quick, reliable, and could target activities aligned with CCSS-M (with specific sites also named as providing engaging activities). One teacher contrasted the experience of using a reliable site with performing a generic search: “After years of searching, finding a reliable website that had tasks that were engaging and challenging is worth prepping the materials for, versus finding the generic worksheets that don't provide the depth that I'm looking for.” Teachers who were specifically searching for materials aligned with the CCSS-M standards also found value in returning to these reliable sites, “I want to start with standards, and the sites I use build their resources around the CCSS.” Teachers who named specific sites that they browsed or searched on frequently mentioned two sites: Pinterest (www.pinterest.com) and Teachers Pay Teachers (www.teacherspayteachers.com). In addition to describing these sites as quick and easy, many teachers noted that the materials they found were creative, engaging, and “hands-on.” One teacher specifically identified this affordance as making up for one of the deficiencies of the provided materials, saying that other teachers’ ideas on Pinterest are usually “creative, ready to use, and add a little more variety to topics that can sometimes be very repetitive in the curriculum.”

Table 8

Themes in Teachers' Reasons for Using a Variety of Offline and Online Discovery Approaches

Discovery Approaches	Reasons for Using These Approaches
Offline approaches	efficiency
Searched own collection	efficient and highly relevant to goals
Asked another teacher	trustworthy, proven, relevant to grade
Came across when talking to teachers	trustworthy, organic
Asked math specialist/coach	knowledgeable and helpful
Online approaches	efficiency
Searched online using a generic search engine	efficient, large quantity, updated
Browsed a known website	efficient, reliable, aligned with CCSS-M
Searched online using another approach	creative, engaging, hands-on (Pinterest and Teachers Pay Teachers)

Summary of discovery approaches. Overall, teachers reported that they use their main discovery approach because it is efficient, however exceptions to this pattern illustrate that trustworthiness was also influential. Specifically, teachers found value in talking to other teachers and asking a math coach. These offline-approaches differ from other frequently-used approaches in that they do not lend themselves as readily to an “on-demand active search,” but are rather approaches that have to wait for an opportune moment (e.g., during a grade-level team meeting or on the math specialist’s assigned day). Instead of touting their efficiency, teachers who endorsed these approaches as their main approach focused on the trustworthiness of the source. These teachers noted that they value the knowledge of teacher colleagues and math specialist, and that they value the opportunity to ask questions about the materials. Additional details regarding teachers’ discovery of outside materials will be explored in Chapter 4 within the context of interview analysis.

Summary of Survey Findings

Results from the survey provide an initial look at teachers’ decisions regarding outside materials. The vast majority of participants in this sample considered using outside materials in the 2015-2016 school year, and many of them did so frequently. As hypothesized, teachers were motivated to consider outside materials more frequently when they rated their provided materials as less effective at helping them meet their goals. Teachers also considered outside materials more frequently when their main desired change to their provided materials indicated a need that was difficult to meet with other types of curricular adaptations (such as the common reasons for considering outside materials: to provide more differentiated activities and to provide more engaging activities).

When discovering outside materials, teachers used a wide variety of approaches, both online and offline. Teachers tended to value approaches that were efficient, which includes elements of speed and ease. Offline approaches were also used because of the trustworthiness of the sources (e.g., other teachers), while online approaches had the advantage of uncovering materials that were new (updated to align with CCSS-M) and often creative and engaging.

Initial hypotheses regarding the impact of personal and contextual factors, were that teachers with low self-efficacy for teaching math and low feelings of curricular autonomy would

consider outside materials less frequently, and that teachers' years of experience with the provided materials would relate to teachers' consideration of outside materials. The hypothesis that low self-efficacy for teaching math predicts lower frequency of considering outside materials was not supported by the data, indicating that teachers consider using outside materials for math regardless of how they personally feel about their ability to teach math. Conversely, teachers' reported feelings of greater curricular autonomy did predict a higher frequency of considering outside materials, indicating that teachers who feel greater freedom in their classroom choices are more likely to consider outside materials. Additionally, having more years of experience with the provided materials also predicted a higher frequency of considering outside materials. This relationship was not specifically hypothesized, but may have been due to teachers having a better understanding of the weaknesses of the provided materials, or because more basic adaptations (such as re-arranging or omitting lessons) are made during the initial years with a provided material, leaving time for fine-tuning with outside materials in later years. In chapter 4, teachers' interview responses will be used to explore teachers' decisions around outside materials in more depth, with a particular focus on aspects of the provided materials that teachers found lacking, and the ways in which outside materials make up for those deficiencies.

Chapter 4: Results of Interviews

Overview

Questions in the interview were designed to cover all four phases of the proposed decision process (motivation to consider, discovery of, evaluation of, and preparation/adaptation of outside materials), with a focus on teachers' decisions around a specific outside material. The interviews also provided an opportunity to understand more about the personal and contextual factors that may have influenced teachers' decisions. In this chapter I describe the sample of teacher-interviewees, and explore common themes in their evaluations of the provided materials as well as their decisions regarding outside materials. I also explore several personal and contextual factors that were not included in the survey, but that were revealed by interviews.

Description of Interviewees

Interviewees were invited from three Glencrest schools that had a large number of teachers who frequently considered using outside materials. A total of 21 teachers were invited, and interviews were conducted with all nine teachers who agreed to participate. The group of interviewees cover a range of grade levels and levels of experience, with a skew towards upper elementary grades (no Kindergarten teachers, three teachers across 1st and 2nd grades, and six teachers across 3rd, 4th, and 5th grades). Interviewees also represent a range of ages, which skews slightly older than the survey sample (median 43 years old compared to overall Glencrest median of 39). Teachers were assigned identification numbers based on the order in which the interviews were conducted, and these numbers are used to identify teachers' decisions and quotations throughout this chapter. Table 9 shows additional details on each of the interviewees (note: age and specific years of experience are not reported in order to preserve anonymity).

Table 9

Background Information on Interviewees

Teacher Number	School	Grade Level	Years of K-5 Experience	Rating of Effectiveness of Provided Materials
1	Ogdenville	4 th	1-2	very effective
2	North Haverbrook	5 th	9-14	somewhat effective
3	Brockway	1 st	1-2	very effective
4	Brockway	4 th	9-14	somewhat effective
5	North Haverbrook	4 th	9-14	somewhat effective
6	Brockway	2 nd	1-2	somewhat effective
7	Brockway	3 rd	3-8	somewhat effective
8	Ogdenville	5 th	15+	somewhat effective
9	Ogdenville	1 st	15+	somewhat effective

Evaluation of Provided Materials and Motivation to Consider Outside Materials

In order to contextualize teachers' decisions around the use of outside materials, teachers were asked to describe the quality of their provided materials and any institutional requirements or expectations around their use. In this section, I first describe teachers' perceptions of the requirements around their use of the provided materials, and illustrate the primary theme that teachers felt required to use the provided materials, but with considerable leeway to make adaptations. Next, I describe teachers' evaluations of the provided materials. Consistent with findings from the survey, a primary theme emerged indicating that teachers generally evaluated the provided materials positively (as "a good starting point"), but they identified particular

deficiencies that were closely related to their motivations for considering outside materials. Although teachers' specific responses regarding these deficiencies varied, several consistent sub-themes emerged: Teachers identified a need for activities to differentiate their instruction, a need for less cumbersome materials, and a need for more engaging materials.

Provided materials are required, but with “professional judgment.” When teachers were asked if they were required to use the provided materials, most responded “yes,” quickly followed by a clarification that they have freedom to use professional judgment to adapt the curriculum as they see fit, so long as they cover the same information. All teachers reported minimal pressure to strictly follow the provided materials and pacing guide, although four teachers commented that the views of the principal were consequential, with one teacher reporting that in the past she had experienced more strict oversight. When asked if they would prefer a different expectation from their district, most teachers said no, and that they thought the expectation to use the provided materials was reasonable. As Teacher 1 put it:

I feel like [Glencrest] has the right balance with that. They've purchased a curriculum. It makes sense that they would suggest that we use it—strongly suggest and require it—but I feel like that's the district *policy*, and then how it actually gets *implemented* is they trust their teachers and nobody really follows up on it.

Teachers reported appreciating this feeling of trust by district leaders. Although there were general check-ins from the curriculum department in order to ensure lesson-coverage was aligned with district assessments, they did not feel that these check-ins were overly judgmental or controlling.

Provided materials are a good starting point that also needs adaptation. Each teacher described the provided materials as providing a “pretty good” starting point that also required adaptation and/or supplementation. Teachers used phrases such as “it's mostly sufficient” (Teacher 9), “it's a good starting point” (Teacher 1), “I don't see many gaps in it,” (Teacher 3), and “overall it's fine” (Teacher 2). Although these are not exactly glowing evaluations, it is striking that these teachers—who were specifically selected because they frequently use outside curricular materials—are largely satisfied with their provided materials (they each rated the provided materials as either “somewhat” or “very effective,” as shown in Table 9 on page 38). In describing her general satisfaction with the provided materials, Teacher 1 explained, “Every teacher I know (myself included) uses more of [the provided materials than outside materials]...we use almost all of it...it's just that it needs to be augmented.” All teachers echoed this need for adaptation and supplementation as they described three key weaknesses of the provided materials: the provided materials offer limited opportunities to support low-performing students and challenge high-performing students, the provided materials are cumbersome to use, and the provided materials are boring to students. In the sections that follow, I describe each of these weaknesses and illustrate how these weaknesses motivated teachers' consideration of outside materials.

Motivated to adapt because of limited opportunities for differentiation. Several teachers (five out of nine interviewees) reported that they most often considered outside materials in order to provide additional content to students; either additional background and review, additional extension challenges, or both. Although each of these teachers agreed that the provided materials generally provided a good starting point, they often found the need to provide additional background and/or review in order to ensure students mastered the concepts. At times, this was because the provided materials simply did not have enough content on a particular topic. For example, Teacher 5 reported that her students with low background

knowledge had difficulty understanding the many different approaches to multiplication provided in the textbook, so she focused their work on mastering the standard algorithm. This motivated her need for outside materials because, in her words, “the unit doesn’t have a lot of drill pages where it’s just them multiplying over and over and over again. And I know that can be boring, but that’s kind of where I’ll start them.” She used a mix of online worksheet generators, online multiplication games, and multiplication story problems using a real-world context in order to “make it a little more flavorful for them, so it’s not as they say, ‘drill and kill.’” For Teacher 7, this motivation to provide additional content was not rooted in a particular lesson or unit, but instead was a general motivation related to her need to provide additional background and academic language supports for her class with a high percentage of English Language Learners. This motivated her to consider an outside material that provided a framework for co-creating anchor charts with her students that centered on the big ideas of each unit (for additional details on Teacher 7’s use of this outside material, see page 50).

Teachers also reported a need to differentiate for high-achieving students, and cited the specific students in their classes as justification. Glencrest, which overall has high student performance on standardized mathematics tests, also uses self-contained classrooms for gifted students beginning in second grade. In these classrooms, teachers use the mathematics curriculum for the next higher grade (e.g., second graders use the third grade math curriculum). This led to Teacher 3’s specific motivation to differentiate for her handful of first graders who were identified mid-year as qualifying for the gifted program: “[they] will actually be doing third grade material [next year], so I need to make sure they have the background for that. So I have that group use the Equate game [an outside material], I would try to bring in things that were a challenge for them.” Teacher 5 (who taught at the highest-performing school, North Haverbrook Prep) identified the need to differentiate for high-achieving students as a challenge for all teachers at her school:

The problem we run into at our school is the kids are very high in math when they come to us already [...] so the challenge that we have, is we have to find ways to extend what we’re doing in the lessons [...] my supplementation [with outside materials] comes in because I want to be able to stick with the focus [of the provided materials’ topic], so everybody’s doing the same focus, but then I want to also feed the hungry kids.

This need to “feed the hungry kids” was a primary focus for Teacher 5 at North Haverbrook, but only one half of the challenge for Teacher 4 at Brockway (a lower performing school). As she explained: “I have kids who—according to our progress monitoring—perform in the seventh grade, and I have kids performing in the second grade range. So [outside] materials that claim to be very easy to differentiate? Yes please!” Teachers also noted that the provided materials did offer some activities intended to support differentiation, however their critiques of these activities mirror the other key deficiencies of the provided materials: these activities were difficult to use, and boring to students, as described in the following two sections.

Motivated to adapt because provided materials are cumbersome. One common downside of the provided materials that teachers described (mentioned by five out of nine interviewees) is that the materials are wordy, disjointed, and cumbersome to use. Some teachers entirely omitted portions that they felt were too difficult to use, while others attempted to simplify and skim over them. For example, Teacher 5 described typical adaptations she would make to clarify a task as she explained it to students; with the student page projected at the front of the room, she would tell her class, “We’re going to ignore that, we’re going to ignore that, let me put that in kid-speak because it’s very confusing the way they’re wording it...let’s ignore all

those directions because basically here's what they're telling you in a nutshell." These "nutshell" explanations allowed her to streamline certain activities, and summarize but not delve into others. Other teachers completely omitted aspects of the provided materials that they found difficult to use. For Teacher 9, the physical task of manipulating and reading a heavy and text-rich teacher edition drew her away from staying fully engaged with her first graders, so she used an outside material that projected succinct slides on the board (see description of Linda's decisions in chapter 5 for additional detail). Similarly, Teacher 6 reported that she often taught from the lightweight student book, and went on to describe that her ideal curriculum would be set up in a similar way: "This is the standard. This is the strategy. Here's what it might look like on the board. Here's a few bullet points, done! [...it could] have almost like a footnote, citing where you can get more information, and then your gigantic fifteen pound book is on a shelf."

The sheer quantity of materials offered by the provided curriculum overwhelmed and frustrated some teachers. In addition to the core components (a two-volume Teacher Edition, a Student Activity Book, a Homework and Remembering book, and an Assessment guide), the provided materials include an array of other physical and digital resources (e.g., a "Response to Intervention" book, a "Differentiated Instruction Activity Card Kit," and various manipulative kits). Teacher 7 reported that she often suspected that the provided materials might offer something that she wanted, but its confusing organization and lack of alignment between the teacher edition and other materials made it cumbersome to uncover, "I just don't want to sit down and figure it out. So sometimes I think we're recreating things that I'm sure we actually do have access to [through the provided materials]." Teacher 2 was even more dismissive of the provided materials, particularly its confusing array of books and other materials, and tended to look for materials online instead: "there are so many different materials, that you just can't be an expert on all of them. So it's easier for me to be an expert in the things that *I* do, than it is to try and figure out how *their* things connect to mine, when the internet is so much faster." Although most teachers were willing to *try* to use the provided materials, they often came up against an even more frustrating deficiency: the provided materials were simply boring.

Motivated to adapt because provided materials are boring. Although all teachers identified a need for engaging materials when considering outside materials (see evaluation section on page 44 for details), four teachers specifically critiqued the provided materials as being boring and repetitive for students. They often linked this negative evaluation directly to their need for adaptation, such as Teacher 9 who commented: "it's a lot of the same old stuff all the time, so that's where we find that we want to just add a little bit more to it—you have to just keep them interested." Many of these teachers supplemented with outside games, making an explicit link to the weakness of the provided materials: "It's really dry. The kids consider it boring. That's why I do so many games" (Teacher 3). Although teachers recognized ways in which the provided materials tried to engage students, they noted that these efforts often fell flat. As one teacher put it: "They have what they call 'activities' in the textbook that aren't really activities...I think it's called 'Math Activity' or something, but it's really just more *work*...it just seems like a title" (Teacher 8). Teacher 6 also reported that the provided activities did not meet her needs because they were difficult for students to do independently, and they did not hold students' interest. When discussing the provided materials' attempt to provide opportunities for differentiation via its Differentiated Instruction Activity Card Kit, she described: "it might take five minutes for some kids to figure out what they're supposed to be doing, but then once they've figured out it takes like a minute or two, and then they don't know what to do next. So you have to supplement." She went on to describe the outside materials that she found useful: "...things

that we know and recognize as games—you've got a board, you've got pieces, you've got dice, you've got instructions... It would be helpful if they were provided.” Teachers’ evaluations of the provided materials as boring provided a particularly strong motivation for their use of outside materials, as this motivation often called for entirely different activities. This contrasts with some of the simpler adaptations teachers were able to make in response to other identified needs described earlier, such as reducing the number of problems to differentiate for low-performing students, or using a nutshell summary to replace a wordy explanation.

Summary of themes in motivation to consider outside materials. Interviews revealed that teachers were motivated to consider outside materials because their provided materials offered limited opportunity to differentiate, were cumbersome to use, and were boring to students. Two of these themes echo those identified in the survey: most teachers reported that they often or almost always considered outside materials to provide students with extra review of concepts (73%) and extra challenge (76%), and most teachers reported that they often or almost always considered outside materials to provide a more engaging activity (65%). However the third theme (teachers were motivated to consider outside materials because the provided materials were cumbersome to use), was not included in the survey, and was therefore unexpected.

In addition to these overall themes, teachers’ interview responses revealed two types of motivation: general and specific. Teachers’ *general* motivations to consider outside materials were based on areas of mismatch between their overall evaluation of the provided materials and their goals for teaching. This motivated teachers to incorporate outside materials throughout each lesson, regardless of their evaluation of the particular lesson. For example, Teacher 6—who evaluated the entirety of the provided materials as boring for students—incorporated outside fluency games into her daily routine for all lessons. Teachers’ *specific* motivations to consider outside materials were based on negative evaluations of specific units, lessons, or parts of lessons. Those elements were then either replaced by or heavily adapted with outside materials. For example, Teacher 5—who found that the provided unit on multiplication did not offer enough practice in the standard algorithm—incorporated outside worksheets and games in order to provide this practice. Interviews also showed that both general and specific motivations may operate at the same time, as illustrated by the case of Linda in chapter 5.

Themes in Discovery of Outside Materials

During interviews, teachers were asked to pick a specific outside material that they considered in the previous school year, and describe how they first discovered it. The most notable finding regarding interviewees’ discovery approaches is the sheer variety of approaches they used. Most teachers (six out of nine interviewees) reported offline discovery, and most (five out of nine) found their specific outside material without active search. Among these five teachers who came across their outside material through passive approaches, each teacher did so in a different way: one at a conference, one reading the newspaper, one via fellow teachers, one via the school math specialist, and one via a garage sale. Of the remaining four teachers, two engaged in active search and two already knew about their materials from their curricular libraries. The two teachers who described using their own curricular libraries used materials that originally came from different sources: one created from scratch years ago, and one recommended by a professor while in grad school. The two teachers who described using an active search both used known websites, each geared towards very different types of materials (one entirely for worksheets, and the other skewed towards interactive activities). This variety in teachers’ discovery approaches illustrates that teachers are able to find valuable outside materials

that meet their identified needs through a wide range of active and passive approaches, both online and offline (see Table 10 for details).

Table 10

Teachers' Discovery Approaches for the Specific Outside Material Discussed in their Interview

Teacher Number	Specific Outside Material	Discovery Approach	
		Online Approach?	Specific Approach
1	strategies and prompts for classroom discussions; <i>Number Talks</i>		go to own curricular library (material recommended by professor)
2	long-term project to plan a road trip using a variety of math skills		go to own curricular library (material created from scratch years ago)
3	board game with dry erase and spinner for addition/subtraction fluency		came across at a garage sale
4	strategies for promoting classroom discussions; <i>Intentional Talk</i>		came across via recommendation from school math specialist
5	worksheets on measurement with definitions and worked examples	yes	active search via known website (Super Teacher Worksheets)
6	art activity using base-ten blocks to understand place value		came across via other grade-level teachers
7	suite of strategies for supporting ELL students with background charts		came across at a conference
8	newspaper article containing linear measurements in real situation	yes	came across while reading newspaper
9	interactive whiteboard lesson-opener explaining $>$, $<$, and $=$ symbols	yes	active search via known website (Pinterest)

Summary of teachers' discovery of outside materials. The finding that interviewees used a range of approaches to discover their specific outside material is consistent with results of the survey which found that no single type of approach was identified as the “main” approach by a majority of teachers. The survey found that approximately 20% of teachers identified “searching own curricular library” as their main approach (similar to the two out of nine interviewees who described this approach), and approximately 20% of teachers identified “browsing a known website” as their main approach (similar to the two out of nine interviewees who described this approach). However, the survey—which focused on active discovery approaches—did not fully capture the variety of ways in which teachers came across outside materials. This points to a need for additional research to explore a wider range of teachers' approaches towards discovering outside curricular materials.

Themes in Evaluation Criteria for Outside Materials

Themes in teachers' evaluations of outside materials mirrored their reasons for considering outside materials in the first place. As described earlier, teachers described three central motivations for considering outside materials: provided materials offered limited opportunity to differentiate, provided materials were cumbersome to use, and provided materials were boring for students. In describing their evaluations of outside materials, teachers' criteria mirrored these areas of identified need: they evaluated materials highly that were easy to differentiate, that were easy to put into use, and that were engaging for students.

Materials that are easy to differentiate. Although only one teacher identified a material's ease of differentiation as the *most* influential factor when evaluating an outside material, five teachers reported high evaluations of materials that supported them in meeting the needs of students above and/or below grade level. Teachers linked this evaluation criteria to the fact that their provided materials include plenty of support for on-grade-level students, so when considering outside materials they were "a bit more looking for how to differentiate for those two groups [students above and below grade level]" (Teacher 6). Teacher 4 identified this criterion as most influential on her decision to use an outside material. When evaluating a potential outside material, she asks herself questions such as: "Is it differentiable? If that's a word [...] How open-ended is the problem? How many different possible solutions are there?" The fact that this evaluation criteria was rated as highly influential is consistent with teachers' evaluation of their provided materials as offering limited useful opportunities for differentiation, and provides further support for the hypothesis that teachers consider outside materials to make up for deficiencies in the provided materials.

Materials that are easy to put into use. Similar to the ease-of-differentiation criterion, only one teacher identified "easy to use" as her *most* influential factor when evaluating outside materials, however many teachers were enthusiastic about outside materials that were quick to prepare (five teachers rated as highly influential), quick to learn how to use (six teachers rated as highly influential), and affordable (seven teachers rated as highly influential). Teachers tended not to go into depth about these evaluations, but indicated their enthusiasm in their tone of voice and/or quick comments, such as the teachers who read "quick to prepare" on the interview questionnaire and replied, "Oh yeah, *big* for me, yes. I have five minutes, ack!" (Teacher 4), and "*Very* influential because I usually shoot things out of my printer right away" (Teacher 5). Teacher 2 referenced her evaluation of the provided materials as taking too much time to figure out when she explained, "Easy to use. That is my number one. I avoid things that are hard to use [...] I want it to be easy-access for the students and for myself." The influence of this cluster of "easy to use" criteria (which includes being quick to prepare, quick to learn how to use, and affordable) also supports the hypothesis that teachers consider outside materials in response to deficiencies in their provided materials (in this case, the cumbersome aspects of managing the provided materials).

Materials that are engaging. The strongest theme in teachers' evaluations of outside materials—endorsed by every teacher at some point in their interview—was that outside materials were evaluated highly when they were perceived to be more engaging for students than the provided materials. Six of the nine teachers also identified this as the most influential factor on their evaluations of outside materials. However, teachers differed in their descriptions of what constituted an engaging activity. Some teachers used interactive activities and fun games to increase engagement. Some teachers emphasized that engagement came through building connections to the real world, to other disciplines, and to their own lives. While other teachers found their students to be most engaged when they were challenged to construct their own understandings with rigorous material. Here, I describe each of these views of engagement, and show how differences in teachers' views of engagement led to differences in their decisions around outside materials.

Engagement through interaction. Teachers who saw engagement as occurring through interaction gave negative evaluations of the provided teacher scripts and student worksheets, and positive evaluations of outside materials that involved games and other hands-on activities. Teacher 5 used a variety of games to engage students as she worked with small groups; this

included computer games (which she described as “the ones that are the most engaging”) and what she called “Ziploc bag games.” Ziploc bag games are games that are simple and self-contained, where she could prepare materials one time (e.g., fraction equivalencies on cardstock with instructions to use the cards to play a game of memory), put them all in a Ziploc bag, and then allow students to use the materials independently while she worked with a small group. Teacher 3’s math lessons also included a rotation in which students moved between small group instruction with her, computerized math practice, and a games station (see bottom of *Figure 6* for example).

Provided materials:

Count on to find the unknown partner.

1. $3 + \boxed{3} = 6$ 2. $7 + \boxed{3} = 10$ 3. $2 + \boxed{4} = 6$
 4. $7 + \boxed{2} = 9$ 5. $4 + \boxed{4} = 8$ 6. $5 + \boxed{3} = 8$

Outside materials:



Figure 6. Teacher 3 evaluated her provided materials as boring (top; Fuson, 2013a, p. 201), and came across an outside material that was more engaging and interactive for her students (bottom; The Board Dudes, 2009).

The game shown in *Figure 6* consists of a large, colorfully decorated dry-erase board with four spinners. Students spin the spinners to identify two numerals (from 1-12) to include in simple addition and subtraction problems. Although the content clearly relates to standards she covers in her first grade class (shown in top of *Figure 6*), Teacher 3 described her initial evaluation of this game as primarily related to student engagement: “the week before I had just introduced dry erase markers, and the kids were really into them, so I was trying to think of things we could do with dry erase markers, and I saw this game, and I was like ‘oh my goodness!’”

Apart from games, these teachers also appreciated other types of instructional materials that they saw as fun and interactive. Teacher 9 described an outside material called “double bubbles,” in which numbered soap bubbles are projected onto an interactive whiteboard, and students call out its double before touching it to “pop” the bubble. She reported that “the kids absolutely love this [...] its just a fun, really engaging interactive way to start off the lesson” (see

description of Linda’s decisions in chapter 5 for additional details on her use of interactive whiteboard lesson-openers). These teachers, whose view of engagement focused on the inclusion of fun and interactive activities, tended to teach younger students (the three first and second grade teachers fell into this group, as well as one fourth grade teacher). Teachers of older grades tended to see engagement as making connections to the real world, or providing opportunities for constructing one’s own understanding, as described below.

Engagement through connections. Teachers who saw engagement as occurring through connections to the real-world and students’ own experiences tended to give negative evaluations of the provided materials’ lack of authentic connections, and gave positive evaluations of outside materials that included a connection to a real-life event or a topic that was relatable to their students. They also identified the act of making connections as central to the nature of math and high-quality math instruction. The two teachers who sought out connections most consistently (Teacher 2 and Teacher 8, both fifth-grade teachers) appreciated that the provided materials made some attempts to connect to the real world, but they frequently found these connections to be either limited in quantity or depth. Teacher 2 liked that the provided materials tried to offer connections to other subjects such as art and science, but tended to not find these connections very engaging for her students. For example, in a provided lesson on division, she pointed out an activity that was advertised as an “art connection” (see top of *Figure 7*). In this activity, students design a new coin, and write word problems in which multiplication or division must be used. She referred to this connection as “kind of lame,” and described her preferred outside material: a long-term project in which students plan a road trip (brief portion shown in bottom of *Figure 7*).

Provided materials:



Art Connection

Coin Designs Have students design their own coin that has a decimal value different from the coins already in circulation. At least one side of their coin design must state its value. Students should explain why they chose the value they did for their new coin. Then have students write at least two word problems about their coin that require using multiplication or division to solve.



Outside materials:

Mileage Math

First fill up:

_____ = A
(odometer reading)

Second fill up:

_____ (gallons of gas)

_____ = C
(odometer reading)

**Ask your parents to help you gather this information when they fill up their car. You need to take the initial reading when they fill up the first time and the second after the second time.

Formula

$C - A = D$ (miles traveled)

$D/B = \text{MPG}$ (miles per gallon)

Figure 7. Teacher 2 evaluated her outside materials as “kind of lame” (top; Fuson, 2013d, p. 454), and used an outside material with a more engaging real-world connection (bottom; brief part of a long-term project created by Teacher 2).

Teacher 2 found her road-trip project more engaging for students because it included more authentic connections to other disciplines (e.g., an artistic portion in which students designed a travel brochure for one of the cities on their route) and because it included real facts and situations (students researched real cities, routes, restaurants, and lodging). In addition to a critique of the provided activities that specifically claim to offer connections, Teacher 8 was frustrated by the lack of real-world connections throughout all problems: “That is huge for me—it’s real world, it’s something that’s really happening [...] [the provided materials] use these way too much, where they’re just coming up with fictional stuff—it’s not adding to the depth of the problem.”

Both Teacher 2 and Teacher 8 identified the ability to make connections as a central part of their goal for math teaching and their view of the nature of math. Teacher 2 described her desire to see students engaged in inter-disciplinary tasks (e.g., fractal art) that connected other fields to the concepts they learned about in math. Similarly, Teacher 8’s view of math as a “tool for learning” provides an explanation for why he evaluated connections so highly: not only do they engage students in learning the math content, but the connections themselves are the learning (see description of Gene’s decisions in chapter 5 for additional details on his use of real-world connections in his lessons).

Although only two teachers focused specifically on the need for authentic connections, several other teachers made passing comments indicating that the provided materials were not relatable to their students. Teacher 9 used a series of story problems created by a teammate that included Pokémon cards and other things their students were interested in, noting that these outside story problems “drew [the students] in so much more than [the provided materials] ‘five bunnies were at the field...’” In critiquing the “real-world” context of a provided activity that involved a menu of sub sandwiches, Teacher 4 cited the diverse cultural backgrounds of her students as she questioned whose “world” the curriculum developers were writing for:

Not many of [my students] really eat sandwiches. Like, ever. Not the culture. We’re not an Italian people over there at [Brockway], so it’s not the most culturally relevant to them. Give me some naan, or a tortilla, or Cheetos! Kids love them some Cheetos!

Similarly, Teacher 6 identified these areas of cultural disconnect as not just failing to engage her students, but actively disengaging them. In describing one aspect of engagement for her students, she explained that story problems about vacations, birthday parties with dozens of guests, and goody bags could be “very disengaging” for her students, “because these kids might not be able to do that.” These teachers reported that they tended to skim the provided materials before using, skip over problems that they evaluated as disengaging for their students, and supplement with more relevant contexts when possible.

Engagement through constructing one’s own understanding. Two teachers saw engagement as occurring through the opportunity to construct one’s own understanding through rigorous tasks and discussions. These teachers (Teacher 1 and Teacher 4, both fourth grade teachers) tended to evaluate the provided materials negatively for jumping quickly to definitions and rules, without allowing enough opportunity for discovery and for students to and “grapple” with new concepts on their own. They evaluated outside materials highly that included open-ended discussion prompts or that supported their efforts to put students’ thinking at the center of their lessons. In order to do this, both teachers used the book *Number talks: Helping children build mental math and computation strategies, Grades K-5* (Parrish, 2010). Teacher 4 had also recently begun using the book *Intentional talk: How to structure and lead productive mathematical discussions* (Kazemi & Hintz, 2014), which was recommended by her school’s

math specialist. She preferred materials like *Intentional Talk* over the provided materials because it allowed students to be in the center of the learning, rather than waiting for the provided materials to provide a rule (shown in top of *Figure 8*): “[the provided curriculum] moves pretty quickly into that rule, without giving kids time to own the process.” Both Teacher 4 and Teacher 1 reported that they preferred to offer discussion opportunities such as those shown in the bottom of *Figure 8*, in which students do most of the thinking and talking, and the teacher takes a more restrained role.

Provided materials:

14. $\frac{1}{7} < \frac{1}{4}$

15. $\frac{1}{9} > \frac{1}{12}$

16. $\frac{1}{9} > \frac{1}{11}$

17. Complete this statement:

When comparing two unit fractions, the fraction with the smaller denominator is greater.

Outside materials:

Kurt: Well, I was just thinking that we learned that $\frac{10}{10}$ is equal to a whole. But 8 point 10 looks like 8 point 1.

Thomasina: Oh, oh. Yeah, I see what Kurt is saying. It's like $8\frac{10}{10}$ is like 8 and 1 whole. So doesn't that mean it's 9?

Ms. Allen: What do you think of what Thomasina and Kurt are saying, Alisa?

Ms. Allen's decision to go back to Alisa is intentional here. She regularly looks for opportunities for students to make their puzzlements more public, to show that wrestling with ideas is an important part of doing mathematics.

Alisa: I think I need to hear that again. It's starting to make sense.

Thomasina gets up to go to the board and gets an approving nod from Ms. Allen.

Figure 8. Teacher 4 felt her provided materials moved too quickly into “rules” (top; Fuson, 2013b, p. 529), and used an outside material that supported her goal of students owning the learning process (bottom; Kazemi & Hintz, 2014, p. 103).

These negative evaluations of the provided materials and positive evaluations of materials that supported student discussion were tightly linked to these teachers' views of math teaching and learning, and their desire for engaging lessons. As Teacher 1 explained when describing her views of high-quality math instruction:

Mostly [students] should be working and *they* should be sweating and *they* should be talking and *I* should just be sitting back and guiding it all—so that's what rigorous math instruction looks like [...] because if there's no way for them to construct the knowledge, there's no way for them to have to grapple with it. And grappling with it when I'm there and their peers are there provides them the support to get them to understanding.

Both teachers linked this type of instruction to better student engagement, which they saw as providing multiple benefits for students: students retain concepts better, students see themselves as mathematicians, and students persevere when they are faced with novel mathematical problems. Teacher 4 elaborated on this last benefit, and linked it to her end-of-the-year standardized test: “if you're always telling them how to do something, [then] when they come to an unknown problem (which if they're doing well on Smarter Balanced they *will*, because it's adaptive) they're going to shut down.” Thus, in addition to supplementing with outside materials that provided students with opportunities to discover mathematical ideas, these teachers also had to carefully omit or postpone the rule-focused portions of the provided materials in order to ensure that they did not undermine their own goals.

Summary of themes in evaluation criteria for outside materials. Teachers evaluated outside materials highly when they were easy to differentiate, easy to put into use, and most importantly, engaging for their students. Interesting patterns emerged in the different ways that teachers described engaging activities. Teachers of earlier grades tended to focus on the interactive nature of the activities, focusing on materials that were fun for students. Two teachers viewed high-quality instruction as that which builds connections to other disciplines and uses math to understand the real world. They focused their positive evaluations on outside materials that helped them build these connections. Two other teachers viewed high-quality instruction as that in which students construct knowledge for themselves through deep discussions. These teachers focused their positive evaluations on outside materials that provided access points for students to build understandings and own the process of learning. Each of these three ways of viewing engagement are explored in more detail through illustrations of the decisions of three focal teachers in chapter 5.

Themes in Preparation and Adaptation of Outside Materials

Teachers' preparation and adaptation of outside materials was typically minimal and clustered into two types: use of outside materials “as-is,” and adaptation of outside materials for different student-ability levels. Teachers' minimal preparation is in line with the finding that they gave positive evaluations to outside materials that were easy to use, as one factor that contributes to ease-of-use is minimal preparation requirements. Their responses also suggest that their needs to prepare or adapt outside materials were minimal because they used discovery approaches and evaluation criteria that filtered potential materials to those in line with their identified needs. Therefore, after finding outside materials that met their specific needs, teachers felt little need to spend additional time on adaptation. One notable exception to these themes is also presented here in order to shed light on how districts may support the needs of teachers who are feeling ineffective in supporting the needs of their students.

Use of outside materials as-is, with minimal preparation. Most teachers (five out of nine interviewees) reported using outside materials with virtually no adaptations and minimal preparation because they had already filtered out materials that would require adaptation during the discovery and evaluation phases. For example, Teacher 2 used a road-trip-planning project (shown in the bottom of *Figure 7* on page 46) that she created years ago to provide students with an authentic real-world connection and which has now become part of her curricular library. Thus this material was already tailored specifically to include content that she identified as important and features that make it easy for her students to use. Teacher 5 printed worksheets off of www.superteacherworksheets.com and used them as-is because they met her two evaluation criteria: they included more challenging numbers than the provided materials, and they included directions and examples at the top to support her students in completing them

independently. Teacher 6 used an art activity suggested by her teacher colleagues in which students arrange base-ten manipulatives in the shape of animals to model three-digit numbers, which she evaluated as more engaging than her provided materials' approach to modeling three-digit numbers. This expands upon the finding that teachers evaluated outside materials highly that were easy to use, as it suggests that "requiring minimal adaptation" may be part of what influences teachers to view materials as easy to use in the first place.

Prepare and adapt to differentiate for various student-ability levels. Three teachers who did not use their outside materials as-is, instead engaged in preparation and adaptation with a specific focus on differentiating to the ability-levels of students in their classrooms. For Teacher 1, this involved preparing for each class by selecting a discussion prompt that offered access points for her lower-performing students, and an opportunity to "stretch" for her higher-performing students (see description of Tina's decisions in chapter 5 for additional detail). Teacher 4, who also used outside discussion prompts, encouraged students to modulate their own level of difficulty by choosing tasks that were challenging for *them*. Referring to a prompt in which students choose two fractions and compare their value, she explained: "my lower kids can compare one third and one fifth, but my higher kids could really challenge themselves to do like two fourths and six twelfths or something like that." Her preparation for this adaptation involved creating a specific "classroom culture" in which it is understood and accepted that students will challenge themselves and all have different answers. Teacher 3 adapted her outside material more directly in order to differentiate for her students. When students used the dry-erase spinner game (shown in the bottom of *Figure 6* on page 45) she required that they write down their equations and model them with pictures in order to ensure that students made the connection between the numerals and real applications. She further adapted the game to challenge her high-achieving students by requiring that they spin each spinner twice (introducing larger numbers into the equations), and that they have one spinner control the total (introducing unknown addends into the equations before they had been introduced by the provided materials).

Notable exception: Insufficient preparation and unintended adaptations. One notable exception to the patterns described above is captured by Teacher 7's use of a suite of strategies to support her students with low background knowledge (particularly her English Language Learners and her Academic Language Learners). Teacher 7 and her grade-level colleagues were motivated to use the "Achievement Inspired Mathematics for Scaffolding Student Success (AIMS4S³)" model to scaffold their instruction during use of the provided materials. As Teacher 7 described it, the model involves reviewing a unit from the provided materials for key ideas and vocabulary, creating an anchor chart (referred to in the model as a "compendium") that previews the key ideas, and incorporating motivational games, chants, and songs to engage students and support their memory of new vocabulary. Teacher 7 and her team learned about the model at a teaching conference, but were not able to attend the three-day workshop to get fully trained: "I was definitely sold on it. I really really wanted to get trained in it, but it costs a lot of money and our district was like, 'eeeerm [not going to pay for it].'" This insufficient preparation for using this outside material (due to lack of training) led to unintended adaptations and a lack of confidence in her use of the model: "we try to do it, but again, it's hard to follow that model with fidelity when you haven't been trained in it, and you're just like, 'I *kind of* understand the concepts.'" Using the model without training (and thus without full access to the online collection of compendiums and motivational games, chants, and songs) was challenging, and often resulted in the unintended adaptation of omitting the "fun" aspects, which

she admitted was “where we kind of fell apart.” Teacher 7’s preparation of her outside material differed from other teachers in that it was both time-consuming and unsatisfactory.

Summary of themes in preparation and adaptation of outside materials. Most teachers engaged in minimal preparation and adaptation of their outside curricular materials, because they chose materials that were highly aligned with their identified needs. Some teachers did include minimal adaptations to support the use of outside materials by students with varying ability levels. These adaptations were typically made on the fly in the classroom, in ways that were purposeful but not time-consuming. The notable exception to these patterns was Teacher 7, whose efforts to use an outside model for scaffolding her instruction were time-consuming, and yet somewhat unsatisfactory due to a lack of training. These findings do not support the tentative hypothesis that teachers liberally adapt outside materials because they feel less beholden to using them with fidelity, and instead they offer support for the tentative hypothesis that teachers make few adaptations because they have “weeded out” materials that require further modification.

Summary of Interview Findings

Results from the interviews provide additional detail to our understanding of teachers’ decisions regarding outside curricular materials in mathematics. While the survey found that teachers were motivated to consider outside materials more frequently when they rated their provided materials as less effective, the interviews revealed close and specific alignment between areas in which teachers were dissatisfied with the provided materials, and the evaluation criteria they used when examining specific outside materials. For teachers in Glencrest—who evaluated their provided materials as having few useful opportunities for differentiation, as being cumbersome to use, and as being boring to students—this meant that they positively evaluated outside materials that were easy to differentiate, easy to use, and engaging for students. The interview format encouraged teachers to elaborate on what specific types of activities promoted engagement for their students, revealing three interesting themes: teachers of younger students valued interactive and “fun” activities, teachers of older students who viewed math as a tool for connecting to other disciplines and learning about the world valued activities that encouraged those connections, and teachers of older students whose view of math learning focused on students constructing their own knowledge valued materials that encouraged student discovery over provided rules. In chapter 5, the interview responses of three focal teachers will be used to trace their decisions around a single outside material, from motivation, to discovery, to evaluation, and finally preparation. In chapter 6, the decisions of these focal teachers will be used to elaborate the research framework and illustrate ways in which the decision-process can proceed differently under different conditions.

Chapter 5: Case Studies of Three Focal Interviewees

In this chapter, I engage in an in-depth description of the decision-making process of three focal teachers, focusing on a specific outside material that they used in their classrooms. These teachers were chosen because they all identified a need for engaging outside materials (a strong theme across interviewees), and because they serve to illustrate the three different views of engagement described in chapter 4: engagement through interaction, engagement through connections, and engagement through constructing understanding. Additionally, the three focal teachers illustrate three different patterns of discovery of outside materials, and chose three very different types of outside materials.

Focal Teachers

The three focal teachers—Linda, Gene, and Tina—are similar in age, represent three different grade levels, have varying degrees of K-5 teaching experience, rated their provided materials as effective, and reported that the majority of their instructional materials were either used directly from or adapted from the provided curriculum (see Table 11 for details). Coincidentally, the three focal teachers all taught at Ogdenville Academy, which was the interview site that was most similar to district averages in its student racial distributions, percentage of low-income students, and percentage of English Language Learners.

Table 11

Background Information on Focal Teachers

	Linda (Teacher 9)	Gene (Teacher 8)	Tina (Teacher 1)
Age	early 40s	early 40s	late 30s
Grade level	1 st	5 th	4 th
Years of K-5 teaching experience	15+	15+	1-2
Rating of effectiveness of provided materials	somewhat effective	somewhat effective	very effective
Percent of instructional materials reported directly from or adapted from provided materials	80%	60%	55%

In the following sections, I describe the decision process of each focal teacher, using a specific outside material to illustrate their decisions. The specific outside materials were chosen by each teacher in response to the question “which outside material would you like to talk about more in-depth?” When describing why they chose their focal materials, each teacher reported that they particularly liked the outside material, and that it represented a common way in which they used outside materials during the school year.

Linda: Active Online Search for an Interactive Lesson-Opener

Linda had a general motivation to consider outside lesson-openers that were easier to use and more engaging than her provided materials. She also held a specific motivation to replace a particular lesson-opener that did not provide students with enough opportunity to practice prior to independent work. This specific motivation prompted her to engage in an active online search in which she positively evaluated materials that had engaging elements as well as repeated practice. Her preparation of the materials was minimal, as her discovery and evaluation decisions led her towards materials that were aligned with the relevant content standard and that would require little preparation. In this section, I describe Linda’s process of deciding to use outside materials in order to illustrate one way in which the process unfolds with active online

search and with outside materials that were created by another teacher to address a specific content standard.

Linda’s motivation to replace provided lesson-openers. Linda was motivated to incorporate outside materials that were fun and visually appealing in order to keep her first-graders engaged during whole-class lesson introductions. In describing her specific motivation to consider her focal outside material, she identified two primary ways in which a particular provided lesson on comparing two-digit numbers did not support student engagement. First, the suggested activities were dull and did not provide enough support before students were expected to work independently. The first three activities included in the teacher edition were a “quick practice” (counting to 100 and performing a movement, such as a clap, each time the class reaches a ten), a whole-class discussion of what the symbols =, >, and < mean, and a whole-class discussion comparing the numbers 34 and 43 using previously-presented tools (secret code cards and sticks/circles, as shown in Figure 9).

Demonstration Secret Code Cards to make two numbers: 34 and 43.

Draw 10-sticks and circles to show both numbers. Lead a discussion to compare the two numbers. Ask questions to make sure children understand what each digit represents.



- (Point to 34.) Which number is the tens digit? **3** What does the 3 in 34 represent? **3 tens or 30** Which number is the ones digit? **4** What does the 4 in 34 represent? **4 ones or 4**

Ask similar questions, this time pointing to the number 43.

- Which is greater, 34 or 43? Why? **43**; Possible response: **43 has 4 tens and 34 has 3 tens. 40 is greater than 30.** How can you write to compare 34 and 43? **43 > 34 or 34 < 43**

Figure 9. Linda’s provided lesson-openers: described as boring and an insufficient introduction (Fuson, 2013a, p. 348).

Linda reported that she chose to skip these activities because they would not be engaging for her students (“it’s just really rote and dull”), and because they provided minimal preparation for independent work: “you’re just basically saying ‘Oh this is the greater than sign, this is the less than sign’...that was it, and then they’re expected to go on their own. So we felt like we needed something more substantial.”¹⁶

The second reason Linda was motivated to consider outside materials was that teaching from the teacher edition was cumbersome and disrupted a steady lesson flow; this in turn made it difficult to maintain engagement with her students. Linda described her practice with the new CCSS-M updated version of the provided materials by saying, “we had the book on our laps, and it was really cumbersome...I couldn’t really wrap my brain around it, I was kind of fumbling

¹⁶ Linda used “we” throughout her interview to describe not only her own evaluations of the provided materials, but also the consensus of her grade-level teacher team, which often collaborated by sharing resources.

around a little bit and I just didn't feel as comfortable and confident in teaching the skills. And then I was kinda losing them too because I had to be writing on the board all the time.” Both of these reasons for considering outside materials are consistent with the more general themes in teachers’ dissatisfaction with the provided materials described earlier: provided materials are cumbersome to manage and boring for students. These areas of identified need motivated Linda to search for materials that were more engaging for her students, and that eliminated any need to turn and write on the board or face down into a book.

Linda’s discovery through online searches and filtering. Linda was motivated to consider an outside material that was engaging and less cumbersome to present; although she did not have a specific material in mind, she did know how to search for it online. She also knew the specific format that was likely to meet both of her identified needs: an interactive whiteboard. Linda’s classroom (as well as many if not all classrooms in Glencrest), are equipped with interactive whiteboards (which she referred to by the brand name “Smart Board”). These boards allow her to project presentation slides (similar to other presentation software such as Microsoft PowerPoint), but with the added feature that children can use special pens to digitally draw in the presentation, and they can touch the projected images to interact with them (e.g., drag and drop symbols, touch an image of a bubble to “pop” it, etc.). Knowing that she wanted a Smart Board activity that introduced the symbols for “greater than” and “less than,” she described her discovery approach as simply entering those search terms in Pinterest (as shown in Figure 10), and then using the site’s “pin” feature to save potentially relevant materials to return to at a later time.

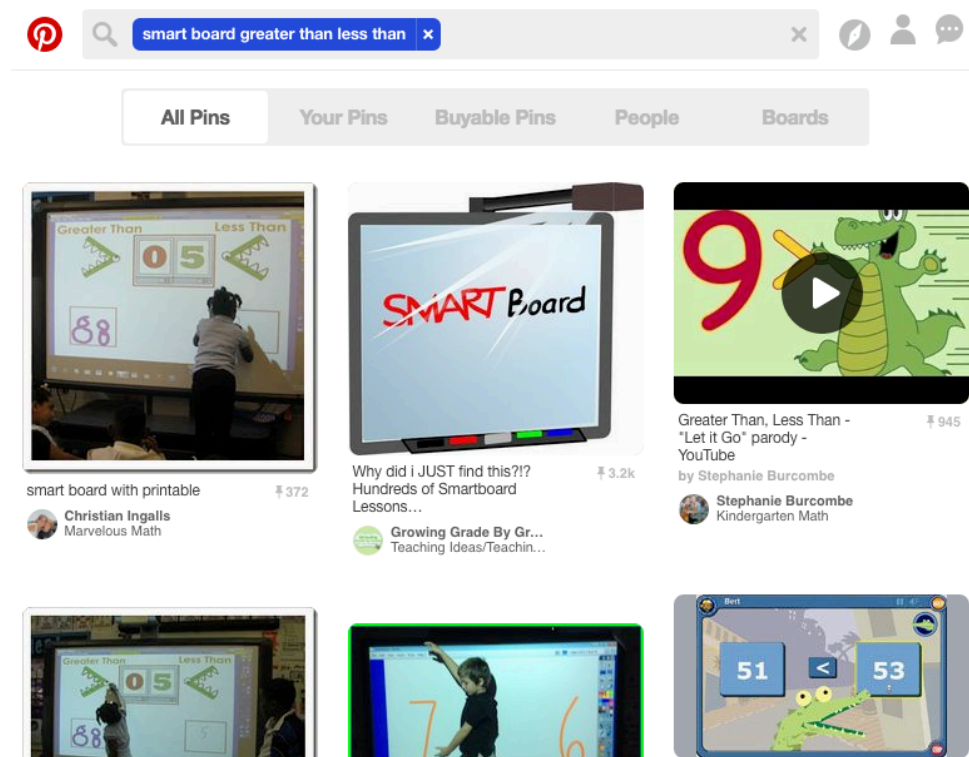


Figure 10. Linda searched via Pinterest, where she could flag several resources to evaluate later.

Linda described her process of filtering online search results by saying: “normally what I do is I pin everything that looks interesting and [that looks like] what I’m looking for. And then I get a little bit overwhelmed with Pinterest, so I have to come back the next day and filter through.”


She valued the ability to easily skim a range of materials, pull together a set of potentially-useful materials, and return to that set at a later time for a more thorough evaluation (she noted that this is also her tactic when using other sites such as Teachers Pay Teachers, in which she can save materials to a wish list).

Linda’s fun and interactive outside lesson-opener. Linda described her process of evaluating outside materials as one that was quick and focused on whether or not the material would be engaging to her students. Her online search led her to a Smart Board lesson that was created by a teacher and made available online for free (Rollinson, 2012). The lesson used open alligator mouths to represent the greater than and less than symbols, provided an explanation of the meaning of the symbols, and included various types of examples. In describing her evaluation, she reported that she immediately identified several features that led her to evaluate it highly: it included engaging visuals (cartoon alligators and fish), a fun song (“[I] knew that kids were gonna love it”), and it was straightforward with plenty of examples (see *Figure 11*).

What does Greater than mean?

If the alligator is hungry he is going to want to eat the bigger number! So the alligator's mouth will face the number that is bigger!

Greater than means bigger than! We also read from left to right. For this example we would say 6 is greater than 4



Drag the greater side of fish to watch them disappear

Lets Practice

Use the pen to draw the correct sign

1.

24		50
----	--	----

3.

73		83
----	--	----

2.

45		41
----	--	----

4.

20		15
----	--	----

Figure 11. Linda’s interactive whiteboard with a song and appealing graphics (Rollinson, 2012; slides #3 and #6).

Note. The lesson includes nine total slides that are shown to students; the third slide is shown at the top of the figure (a student can drag the group of six fish over the alligator and the fish will disappear), and the sixth slide is shown at bottom (students can draw the symbols in the blanks).

The lesson also included introductory slides geared towards the teacher that provided suggestions for potential adaptations, as well as a note regarding the specific content standard it is designed to support (comparing numbers using the symbols $>$, $<$, and $=$). Linda summarized her evaluation of the materials by saying, “[it’s] simple, but yet it gets to that concrete concept that we’re trying to teach, and then it has examples, and then review throughout.” This is in contrast to the provided materials which offered one explanation of the meaning of the symbols, two whole-class examples, and then simply a suggestion to “continue comparing several pairs of 2-digit numbers” before independent work (a suggestion that may be missed by a teacher trying to skim a text-heavy guide while retaining the attention of six-year-olds). She also appreciated the opportunity to connect with her students by telling them that the alligator analogy is how her teacher taught her about the symbols when she was a young girl. Her positive evaluation of Smart Board lessons more generally also influenced her evaluation of this specific outside material; she contrasted her use of Smart Board lessons with her use of the provided materials by saying, “I don’t have to have the teacher edition in front of me, that big ole book. I can just have it all right here...so everything is really easy to follow.” As Linda described it, having materials projected onto the board allowed her to stay focused on her students rather than the text of the teacher edition, and promoted her students’ engagement.

Linda’s evaluation of this lesson-opener *before* instruction (as described above) influenced her decision to use it the first time, but it was her evaluations *during* and *after* instruction that influenced her decision to use these materials in subsequent years. In reflecting and her evaluation of the materials during instruction, she focused on the excitement of her students, saying that they wanted to play the song over and over, and emphasizing that “they were just so *happy* about it.” When evaluating the materials after enactment, she mentioned that she did not see any downsides to using the Smart Board lesson-opener because it was aligned with her provided curricular materials, it offered extra practice, and it did not offer so much extra practice that it took away from the time available for the provided materials. Thus, in addition to evaluating this outside material highly because she saw it as engaging, she also valued its perceived alignment and compatibility with the provided materials.

Linda’s minimal preparation: Downloading. Linda’s preparation of her interactive whiteboard lesson-opener was minimal: she downloaded the file, connected her computer to the Smart Board, and taught her lesson. Although the file can be edited, Linda described a preference for finding materials that meet her needs without additional preparation. While contrasting her adaptations with those of a colleague who finds inspiration in outside materials and then creates his own materials, she laughed saying, “I can’t pull that off.” She noted when she does make adaptations, she typically just removes anything that seems like “too much” for her students, and appreciated the ease with which she could “tweak” Smart Board lessons to suit her needs in this way. Adapting her provided materials to accommodate this outside materials also involved minimal time, as she simply omitted several introductory activities, and transitioned from her outside lesson-opener to the provided independent practice. This minimal amount of preparation is consistent with teachers’ responses across interviews, and is related to her strong positive evaluation of the ways in which her outside material met her needs.

Gene: Passive Discovery of an Interesting Real-World Context

Gene had a general motivation to consider any outside material that he found interesting and rooted in a real-world context. Thus he often discovered outside materials by coming across them in the newspaper or another non-instructional source, rather than specifically searching for a curricular material to replace a particular activity. His decision to incorporate the specific

outside material described below was driven primarily by his evaluation that it was interesting, and only secondarily by its relation to the math content for that specific day. His preparation of the materials was minimal, yet it was important for adapting a non-instructional material to meet his instructional goals. In this section, I describe Gene's process of deciding to use outside materials in order to illustrate one way in which the process unfolds without active search and without outside materials that were specifically designed to be instructional.

Gene's motivation to replace provided "story" problems. Gene's motivation to incorporate outside materials was rooted in his views about what is and is not engaging for his fifth-grade students, as well as his views about the nature of math. Gene viewed the process of learning as a process of "wonder[ing] about the world," and he viewed mathematics as a tool to use during that learning. He elaborated this point by saying, "I'm not *learning math*. I'm *using math* to learn about something else." This view of mathematics as a tool for learning about the real world led him to appreciate aspects of the provided materials that incorporated "real facts" (such as an activity with the actual wingspans of butterflies and moths), and to be dissatisfied to aspects of the provided materials that included entirely fictional scenarios, such as the homework problem shown in *Figure 12*.

Dan's Ice Cream comes in cartons of two sizes. The large carton holds $4\frac{1}{2}$ pounds. The small carton holds $1\frac{3}{4}$ pounds less. How much ice cream does the small carton hold?

$2\frac{3}{4}$ pounds

Figure 12. Gene's provided "story" problems: typically fictional rather than truly real-world (Fuson, 2013e, p. 282).

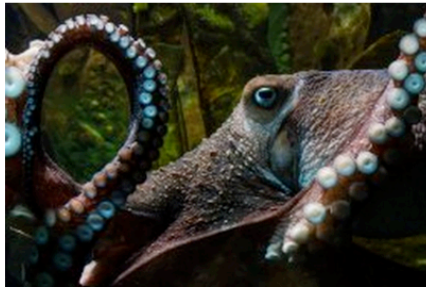
Note. All four story problems on this page included fictional scenarios, and three of them involved "Dan's Ice Cream."

Gene expressed frustration that the fictional aspects of the provided story problems fail to add depth to the problems saying, "I mean, I like ice cream. But you know, why can't you talk about Ben and Jerry's ice cream and how many quarts they're making in a month or something? Bring that realism into it and you actually learn something." Gene's consideration of outside materials was motivated by a general dissatisfaction with the lack of real contexts in the provided materials, rather than any particular deficiencies of a specific lesson. This impacted the ways in which he approached discovery of outside materials, his standards for evaluating outside materials, and preparation of materials for enactment.

Gene's discovery: Coming across outside materials without search. Gene's general motivation to incorporate materials in which math can be used to understand interesting real-world situations caused him to be attentive to those situations in his day-to-day life. For Gene, who typically comes across interesting situations in newspapers and magazines, this approach has the added benefit of providing a point of connection from him to his students. He is able to sincerely tell his students that he just found an interesting situation that he wanted to share with them, which in his words "makes teachers part of the process of learning" by modeling how one can use math to learn about something new. Gene also reported that because the situations are new for him too, he has: "removed the boring factor, as opposed to doing it with something I've taught five years in a row now." Thus, one morning in April, without spending any additional time or energy, Gene came across a real-life math situation in a newspaper article about Inky the octopus, shown in *Figure 13*.

Octopus slithers away from New Zealand Aquarium

Originally published April 13, 2016 at 2:46 pm | Updated April 13, 2016 at 7:52 pm



It was an audacious nighttime escape.

After busting through an enclosure, the nimble contortionist appears to have quietly crossed the floor, slithered through a narrow drain hole about 6 inches in diameter and jumped into the sea. Then he disappeared.

This was no Houdini, but rather a common New Zealand octopus called Inky, about the size of a soccer ball.

Figure 13. Gene reads the newspaper in the morning, keeping that day's teaching in mind (Bilefsky, 2016).

Gene's outside material: An interesting, real-world math story. Gene described two evaluation criteria when deciding whether or not he will incorporate a potentially interesting outside material. First, he asks himself, "will the ideas and concepts be appropriate for the grade level?" and second, "will it be interesting?" Regarding the first criterion, he described less of a focus on the lesson prescribed for that day, and more of a focus on his overall goal for the year. When Gene read the article on Inky the octopus, he noticed several units of measurement. Even though he knew the day's math lesson was not focused on measurement, he reported talking with his students about measurement all year during science, and the math unit on measurement was going to start soon. Because one of his goals for students regarding measurement is for them to understand "what distance should look like in your head, and what it really is," he evaluated the octopus article highly due to multiple opportunities for students to visualize what different units of measurement look like in real-world contexts. Specifically, the octopus' eight-foot trip from its tank to its escape route (a drainpipe) could be easily modeled within the classroom (as Gene put it, "So what does eight feet mean? So it's from Tim's desk to the window..."), the six-inch diameter drainpipe could be modeled by each student with their hands ("a six-inch diameter pipe, what does that look like? Everybody use your hands to make that"), and the 164-foot length of the drainpipe pushed students to consider much larger lengths (see *Figure 14* for the sketch Gene drew with his class as they modeled the situation described by the article).

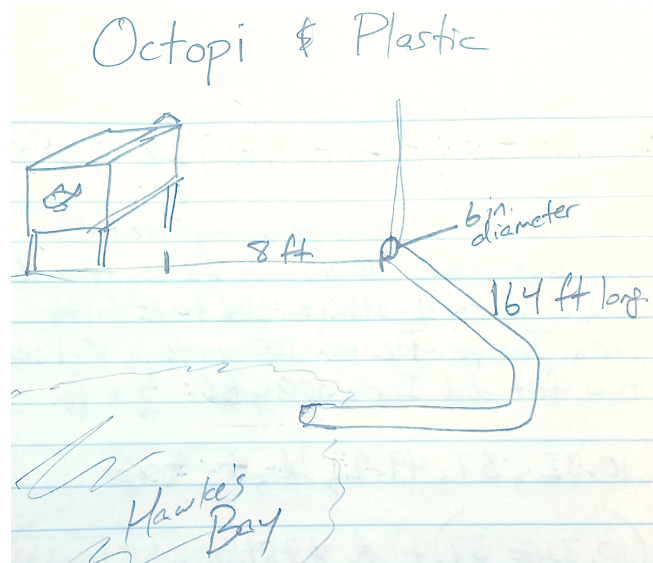


Figure 14. Gene read through the outside article with his class, pausing to model measurements.

Regarding Gene's second criterion for evaluating outside materials ("will it be interesting?"), he reported that this particular article was interesting because it was a real event (as opposed to a fictional scenario created for teaching) that involved an interesting animal and situation. He contrasted the interest-level provided by this real-world situation to the fictional scenarios that are common in his provided materials by saying, "a lot of the kids really do like learning *about* something." His evaluation of this lesson after enactment also provided validation of his belief that it was interesting to students. A month following this math lesson, his class was preparing for a marine science field trip when one student exclaimed "Oh! It's like that octopus in New Zealand!" This is an important part of why Gene seeks out interesting materials—both for engagement during the lesson, as well as for sustained learning and connections afterwards. As he elaborated, "when a kid says something like this, and every other kid in the classroom totally knows what they're talking about, I mean then you know that you really did something that they can stick in their head."

Gene's preparation: Reading and thinking through enactment. Gene's preparation of his outside material was fairly minimal: he re-read the article, thought through a discussion plan, printed copies of the article for his students to read, and ensured that his document camera was ready to project his notebook for him to draw during the lesson (see *Figure 14* for his drawing). He described the process of familiarizing himself with the outside material as important in order to facilitate the lesson, but appreciated that the novelty of the outside material made it interesting for him as well: "I had read [the article] several times, and thought about what I was going to do, and really thought about those numbers—pictured it—and had a clear idea in my head of that lesson before we started, but it was still *new to me*." Gene's adaptation of the provided material in order to accommodate these discussions of outside articles was flexible, and depended on his evaluation of which mathematical topics were most important. At times, a discussion of an outside article would replace part of that day's provided lesson that he found less valuable. At other times, the outside discussion would not replace any of that particular day's lesson, and he would just spread the lesson out over multiple days in order to accommodate his outside materials. This would then lead to him omitting parts of later lessons—or even entire lessons—that he evaluated as less important. Gene described his use of provided materials following a discussion of an outside newspaper article by saying: "it might be that I'm back in the math curriculum, but then by the end of the unit I'm cutting out that last lesson, because I know it's not as important." This is consistent with the overall theme that teachers engaged in minimal adaptation of their outside materials, but contrasts with the decisions of Linda in that it reflects less concern with maintaining alignment with the provided materials.

Tina: Used Curricular Library to Support Students in Building Understandings

Tina had a general motivation to consider outside materials as part of her daily routine in order to ensure that her students had opportunities for deep mathematical discussions, which is an area she found lacking in the provided materials. However unlike the other focal teachers, she did not come across or actively search for her outside materials during the school year—she already had them in her curricular library. This means that part of Tina's evaluation process was completed before this school year, as she had already generally evaluated the set of materials and found them worthy of retaining. However Tina also engaged in specific evaluations of individual prompts in order to select those that would provide the appropriate level of challenge for her students at that time. Her preparation of materials involved both long-term elements (establishing norms for mathematical discussions) and daily elements (anticipating misunderstandings that may emerge in a specific discussion). In this section, I describe Tina's

process of deciding to use outside materials in order to illustrate one way in which the process unfolds with materials that are already known to the teacher and which are used primarily to supplement rather than replace the provided materials.

Tina’s shallow provided math talks. Tina was motivated to incorporate outside materials that engaged her fourth-graders by challenging them to construct their own understandings. This motivation was sparked by two specific areas of dissatisfaction with her provided materials: first, the provided math talks provided limited opportunity for deep discussions and constructing knowledge, and second, the provided materials did not contain enough content to solidify her students’ understandings of abstract concepts. When asked to describe the aspect of her provided materials that she likes the least, Tina replied: “It’s really light on areas where I feel like math is going. For example, I feel like students constructing knowledge together through conversation is *critical* to learning...but this just gives it a cursory glance.” She went on to describe the provided materials’ approach to supporting these conversations through a feature titled “Math Talk” (see *Figure 15* for an example). Although she noted that some of these prompts were better than others, she found them to be fairly limited:

I don’t know how anyone could make a fifteen-minute conversation out of the ridiculous ‘Math Talk.’ It just basically doesn’t have the depth [...] It’s not that it doesn’t try and it doesn’t sometimes get there, but just on a regular basis I find that I need to teach [the provided materials], and then teach a little bit more. Push the kids a little bit deeper.”

► **Discuss Drawing Models** WHOLE CLASS MATH TALK

Ask for Ideas Ask students what they already know about arrays. The discussion should include the following concepts.

- An array has rows and columns of objects.
- Each row has the same number of items.
- Each column has the same number of items.

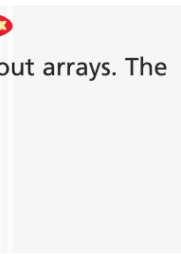
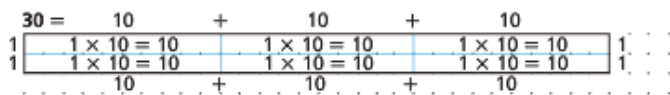


Figure 15. Tina’s provided math talks: described as not deep enough (Fuson, 2013c, p. 116).

Tina’s second area of dissatisfaction with her provided materials was that there was not enough content to support her students’ development of abstract concepts. She focused specifically on the multiplication unit, which uses array models to show that two groups of 30 (2×30) is the same as six groups of 10 (6×10). When describing this model (shown in *Figure 16*) she said, “This is great. It’s the right thing to be showing. My experience is, there’s not *enough* of it. That is such an abstract concept for my students.”

This 2×30 rectangle contains 6 groups of 10 unit squares, so its area is 60 **square units**.



3. How can we show this numerically? Complete the steps.

$$\begin{aligned}
 2 \times 30 &= (2 \times 1) \times (\underline{3} \times 10) \\
 &= (\underline{2} \times \underline{3}) \times (1 \times 10) \\
 &= \underline{6} \times 10 = 60
 \end{aligned}$$

Figure 16. Tina’s provided materials: a good start, but not enough for her students (Fuson, 2013c, p. 120).

She went on to explain that her students are typically able to understand this array model with smaller numbers, but have difficulty making the jump to larger numbers. This motivated her to continue using the array models in her provided materials, but to replace the insufficient math talks with outside materials that would help her students “cement that knowledge and that concept.”

Tina’s discovery: Already known via library. Tina was motivated to consider outside materials that allowed for students to construct their own knowledge, and she already knew the specific resource from her curricular library that would meet her needs. Tina regularly uses strategies and discussion prompts from the book *Number talks: Helping children build mental math and computation strategies, Grades K-5* (Parrish, 2010). She discovered the book several years ago in graduate school when it was recommended by a professor, and reported that she uses the book “constantly” throughout the year. This form of finding outside materials is unique in that the “discovery” has already occurred before any specific motivation to consider outside materials. This raises interesting questions regarding how teachers’ existing curricular libraries may influence their evaluations of the provided materials. Tina mentioned multiple times that the lack of depth in the discussions suggested by the provided materials is what motivated her to use *Number Talks*, however it is just as possible that her prior knowledge of the affordances of *Number Talks* for deep discussions is what influenced her to evaluate the provided materials negatively in the first place. In other words, when teachers have shelves of positively evaluated materials behind their desk, they may be dissatisfied with aspects of their provided materials simply because they already know of a better alternative.

Tina’s rigorous outside math talks. Tina reported that the primary factor she uses to evaluate outside materials is whether or not they will be engaging for her students, which she defined as being accessibly rigorous in order to push students to build their own deep understandings. This was both for the cognitive engagement that accessibly rigorous materials promote, but also the pure enjoyment that students get from accomplishing something difficult: “Kids love really rigorous math. You know, they love stretching for it. Especially if they’re being supported in a way that makes them feel like they can do it even if it’s with some scaffolding.” Tina also identified two other reasons why she generally evaluated *Number Talks* highly: the prompts help her teach students how to have productive math discussions, and help her extend the limited opportunities to grapple with abstract concepts from her provided materials. The wide range of prompt-difficulty allows Tina to begin the year with simpler items to help students “learn the process of how to have math talk.” She then moves on to more complex items in order to help “cement” the important and abstract concepts that are a focus of her fourth-grade standards.

Although Tina’s general positive evaluation of *Number Talks* occurred multiple years ago, she also engaged in specific evaluations of particular prompts in order to ensure they were the appropriate difficulty level for her students at that time. Because *Number Talks* includes many different prompts for each topic, selecting the appropriate difficulty ensures that she does not waste time with prompts that are either too easy (wasted opportunity to stretch) or too hard (wasted opportunity for all students to have access). She used her provided curriculum to support this part of preparation, by considering “the difficulty of what they’re actually learning in the core curriculum—with what we’re doing right at that time—and then I try to keep it a little ahead of where we are.” For example, in order to expand on the array models used in the provided materials (e.g., the model that illustrated “ $2 \times 30 = 6 \times 10$,” shown in *Figure 16* on page 60), Tina reported that she chose the first prompt shown in *Figure 17* below. This is similar

in difficulty to her provided materials as it includes two opportunities to reason with single-digit by two-digit expressions, and also provides an opportunity for students to expand their thinking by considering a two-digit by two-digit expression. She began by writing “ 3×60 ” on the board, and providing students time to think (using only mental math and no writing materials). She then supported a discussion of different strategies and solutions, acting as a recorder of students’ ideas. After repeating this process for the next item (“ 6×30 ”), she supported students in relating the two expressions, and connected back to her provided materials by drawing arrays for each expression (bringing the outside materials into closer alignment with the provided materials). Next, she introduced the last item by saying something similar to: “Okay, I’m putting the last one up...twelve times fifteen. Okay, so you’re thinking ‘How am I supposed to figure out—in my head—twelve times fifteen!’ But, use what you know about *these* [pointing to the earlier items], to see if you can figure out the answer. And you don’t have to try to just calculate it, but see what you can do.” This fifteen to twenty-minute discussion illustrates why Tina evaluates *Number Talks* so highly: simpler items provided students with an access point and feelings of success, while more challenging items provided a true opportunity for her students to “stretch.” Also, the discussion provided a setting to practice explaining and critiquing mathematical thinking, and the depth of the discussion supported her students in understanding abstract concepts.

Category 3: Doubling and Halving

The following number talks investigate doubling and halving with 2×2 -digit numbers.

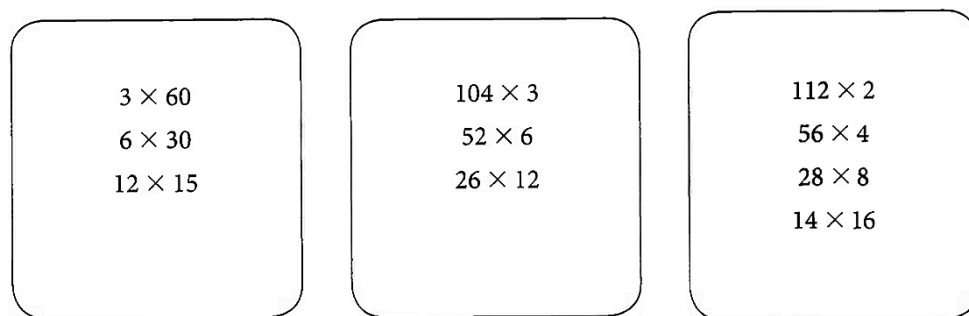


Figure 17. Tina’s Number Talks provided depth to discussions and cemented abstract concepts (Parrish, 2010, p. 280).

Tina used *Number Talks* regularly, and thus had ample opportunity to evaluate its pros and cons after putting it into use. She reported few downsides to using these outside materials because they were well connected to her provided materials: “the skills that we learn here [with *Number Talks*] are so transferable to [the provided materials], just actually *practicing* math talk.” She summarized her evaluation of her outside materials and their complement to her provided materials by saying, “*that* [*Number Talks*] with *this* [the provided curriculum] can get them there, but [the provided curriculum] by itself couldn’t, and of course [*Number Talks*] by itself couldn’t either.” Thus Tina saw her outside materials as a necessary supplement to her provided materials, rather than a replacement.

Tina’s preparation: Establishing norms and anticipating misunderstandings. Similar to the other focal teachers, Tina’s preparation for using her outside materials on a day-to-day basis was fairly minimal, however her particular outside materials also required long-term

preparation starting early in the school year. Tina's daily preparation involved thinking through the different types of strategies and misunderstandings that may surface during the discussion. She did this by working through an anticipated discussion herself, but she noted that "they always surprise me" with the types of misunderstandings they have. Another essential part of Tina's preparation for using these outside materials involves preparing over the first few months of school to develop norms for mathematical discussion in her classroom. She does this by using "problems [from *Number Talks*] that are below grade level" in order for students to begin to "feel comfortable being wrong and critiquing their ideas and the ideas of others." This aspect of preparation is unique among the focal teachers and involved more frequent use of the outside materials at the beginning of the year in order to later use the materials successfully to meet her primary goal: deep discussion of abstract mathematical concepts.

Summary of Focal Teachers

The three focal teachers described in this chapter taught at the same school, used mostly provided materials during instruction, and were all motivated to consider outside materials that were engaging for their students, however their process of deciding to use outside materials differed in striking ways. They differed in their perceptions of what constituted an engaging material, their approaches towards discovering outside materials, and the type of outside material that they decided to incorporate. Linda used an online search to find an interactive lesson-opener developed by another teacher and intended to cover a particular content standard. Gene came across a non-instructional material that he adapted into a task for modeling linear measurement in a real-world situation. Tina already knew about a source for mathematical discussion prompts that helped her engage students by challenging them and providing them an opportunity to construct their own understandings. In chapter 6, these three different instances of making decisions around the use of outside curricular materials will be used to elaborate the research framework that guides this dissertation, and to illustrate its utility in capturing a wide range of decision-processes.

Chapter 6: Discussion

The purpose of this dissertation was to take a first step in examining elementary teachers' decisions around using outside curricular materials for mathematics. Results of an online survey and in-person interviews showed that many teachers frequently considered outside materials in order to make up for perceived deficiencies of their provided materials. They used a variety of active and passive discovery approaches, both online and offline, in order to find a diverse array of materials including worksheets, discussion prompts, games, and even newspaper articles. Teachers evaluated outside materials highly when they addressed specific deficiencies of the provided materials, and tended to either use them as-is or engage in minimal preparation and adaptation. In this chapter I begin by discussing findings related to each phase of the proposed decision-making process, incorporating themes uncovered through the survey, the teacher interviews, and the in-depth analysis of focal teachers' decisions. I then return to the proposed research framework, and use the decision-making of each focal teacher to illustrate how the framework can be used to describe diverse types of decisions around outside materials. Next, I raise questions about unintended consequences of a focal teacher's decisions by engaging in a critical examination of her provided and outside materials. After discussing limitations of the design of this dissertation, and implications for a range of audiences, I conclude by summarizing the contributions of this dissertation to our understanding of teachers' curricular decisions.

Discussion of Findings: What We Know Now

This dissertation expands the literature on teachers' use of mathematics curriculum materials to include the use of outside materials. Although prior research on teachers' curricular decisions focused almost entirely on teachers' use of provided materials, the literature also pointed to several reasons to expect that use of outside materials is a common practice, specifically: teachers are known to omit, adapt, and supplement their provided materials, there may be a mismatch between recently-adopted standards and insufficiently-updated curricular materials, and there are now a multitude of outside resources readily available via the internet. Thus, this study began with many open questions on teachers' decisions around outside materials, which were organized into a research framework into with five central parts: motivation to consider outside materials, approaches to discovering outside materials, criteria for evaluating outside materials, extent of preparation/adaptation of outside materials, and external factors that influence decisions. In the remainder of this section, I briefly summarize the contributions of this dissertation in each of these areas.

Teachers' motivation to consider outside materials. Prior research on teachers' decisions around curricular materials showed that teachers use materials flexibly and make adaptations that are in line with their goals for math teaching. However, no studies had specifically looked at elementary teachers' decisions to use outside materials for math. This dissertation expanded upon this literature by demonstrating that many elementary teachers considered outside materials, and that they did so frequently in order to meet the perceived needs of their students and their goals for instruction. Additionally, findings confirmed the hypothesis that teachers consider outside materials due to significant elements of dissatisfaction with their provided materials. In the case of teachers included in this study, the primary identified needs were a need for differentiation activities and a need for engaging materials, however future research is needed to determine whether these needs are specific to this context, or common among many elementary teachers.

Teachers' discovery of outside materials. Because prior research on teachers' use of curricular materials focused on provided materials, which do not require discovery, there were

no specific hypotheses to explore around teachers' discovery of outside materials. Results did confirm the expectation that teachers would use a wide variety of online and offline discovery approaches in order to meet their goals. Teachers reported a preference for discovery approaches that reliably led them to materials aligned with their goals. Interview results elaborated on this finding and suggested that teachers' choices regarding discovery approaches aided their decisions in the subsequent phases: evaluation and preparation. That is, teachers used discovery approaches that had previously resulted in materials aligned with their evaluation criteria (e.g., a teacher whose evaluation criteria included alignment with the CCSS-M frequently used a discovery approach that allowed her to view materials organized by standard). This appeared to streamline both the evaluation process as well as the preparation/adaptation process (as materials that met multiple evaluation criteria are less likely to require adaptation than those that do not).

Teachers' evaluation of outside materials. Limited existing research on middle- and high-school teachers' evaluation of online materials suggested that teachers evaluate materials highly when they are aligned with standards, use familiar approaches, and require little adaptation. This study revealed three themes in teachers' evaluation criteria that provide an interesting contrast to prior work. First, and most similar to prior work, teachers evaluated materials highly that were easy to use. This included requiring minimal preparation and adaptation, and may also reflect a preference for familiar approaches, as this is likely part of what makes a material easy to use for a teacher. The next two themes reflect a unique contribution of this dissertation, as they were explicitly tied to teachers' motivations for considering outside materials: teachers positively evaluated materials that were easy to differentiate, and that were engaging for students. Additional research is needed in order to clarify whether these specific themes are common among all elementary teachers, or if they are unique to the setting of the teachers interviewed. One might hypothesize that these themes are likely to be common, as elementary teachers need to engage younger students (with shorter attention spans) and teach students with widely varying skill levels (unlike in high school where math classes are more likely to be tracked). However it is also possible that these themes reflect a unique combination of features of the Glencrest context: students with a variety of skill levels, provided materials focused on the "at-grade-level" student, and provided materials with limited opportunities for engagement (identified by teachers as lacking interaction, lacking connections, and lacking opportunities to construct knowledge).

Teachers' preparation and adaptation of outside materials. Prior research demonstrated that teachers spend time preparing to use provided curricular materials, but reports from middle- and high-school teachers suggested that they engage in minimal preparation of materials found online. Findings from this investigation align with prior work and show that although teachers do engage in some preparatory activities, these activities tend to require minimal additional time. The research framework that guided this investigation offers a unique view into one way teachers may achieve this minimal investment into preparation: their time spent using tailored discovery approaches (those that had revealed useful materials in the past) as well as their use of evaluation criteria that were aligned with their initial motivations to consider outside materials, resulted in the selection of outside materials that met their identified needs and required minimal additional preparation. Exceptions to this included teachers who used a particular type of outside material to cover a long span of time, such as Tina who spent the first several months developing norms around mathematical discussions in order to incorporate *Number Talks*, and Teacher 7 who tried to create anchor charts for each unit based on a model of scaffolded instruction. These two teachers provide an interesting contrast, as Tina received an

introduction to her outside materials while in graduate school and was largely satisfied with her use, but Teacher 7 did not receive training on her outside material and was unsatisfied with her ability to use them well. This points to a need for adequate training around the use of some types of outside materials in order to ensure that teachers are using them efficiently, rather than engaging in time-consuming and unsatisfactory preparation.

Relationship of external factors to teachers' decisions. Prior research on teachers' decisions around provided curricular materials suggested that decisions were influenced by four teacher characteristics: their self-efficacy for teaching math, their perceptions of curricular autonomy, their years of experience with the provided curriculum, and their goals for their math teaching. It was hypothesized that these characteristics would also influence teachers' decisions around outside materials, and in many ways that was the case. Although there was no statistically significant relationship between a measure of self-efficacy for teaching math and teachers' frequency of considering outside materials, higher feelings of curricular autonomy and more years of experience with the provided curriculum were both associated with higher frequency of considering outside materials.

Additionally, a review of existing literature suggested that teachers may be motivated to consider outside materials in part because of a perceived mismatch between their provided materials and the CCSS-M. In a pilot study, teachers identified this mismatch, and linked it to their motivation to consider outside materials. Results from this dissertation did not indicate that the CCSS-M was a common motivator for teachers to consider outside materials,¹⁷ but rather it influenced teachers' discovery approaches, as they appreciated websites that allowed them to search or filter by standard. However, two teachers (Teacher 1 and Teacher 4) did make comments that indicate a mismatch between their provided materials and the Common Core State Standards for Mathematical Practice (CCSS-MP). These teachers noted that the provided materials did not provide sufficient opportunity for their students to build their own understandings by engaging in practices such as persevering through rigorous problems (CCSS-MP1) and constructing and critiquing arguments (CCSS-MP3). This, combined with their view that these practices are central to math learning, motivated them to consider outside materials that pushed their students to "grapple" with challenging problems and that supported themselves in guiding mathematically deep discussions. Other teachers whose views of math learning focused on other priorities (such as making connections to other disciplines, working with peers, or learning steps for solving problems) were less critical of the provided materials' lack of support for the CCSS-MP. This provides further evidence that teachers' views regarding mathematics instruction influence the ways in which they evaluate the provided materials, and therefore the outside materials that they consider.

Elaborating the Research Framework: Diverse Pathways in Teachers' Decisions

In chapter 1, I introduced the research framework that guided this investigation of teachers' decisions around outside curricular materials. There, I explained that the framework provides a general overview of four phases (motivation, discovery, evaluation, and

¹⁷ One potential explanation for this disconnect between the current study and prior research, is that the prior research is now outdated (studies describing this mismatch were published multiple years ago and pilot data describing a mismatch was collected during the 2013-2014 school year). In the current study, both districts used a provided curriculum that was intended to fully align with the CCSS-M, and Glencrest's curriculum department also provided a pacing guide that may have provided additional support for alignment between the provided materials and the CCSS-M.

preparation/adaptation), and that it does not include every potential aspect of the decision process (such as teacher colleagues). Here, I elaborate upon the general framework to show that although it does not include *every* part of teachers' decisions, it can be used to describe important parts of any decision to use an outside curricular material. *Figure 18* contains a representation of the framework introduced in chapter 1, but with edits to focus on aspects of the process that were covered in depth during interviews. This includes teachers' views of math teaching and learning, their views regarding the provided materials, and their goals for their classroom teaching (shown at the bottom of *Figure 18* as factors that influence the entire decision process).

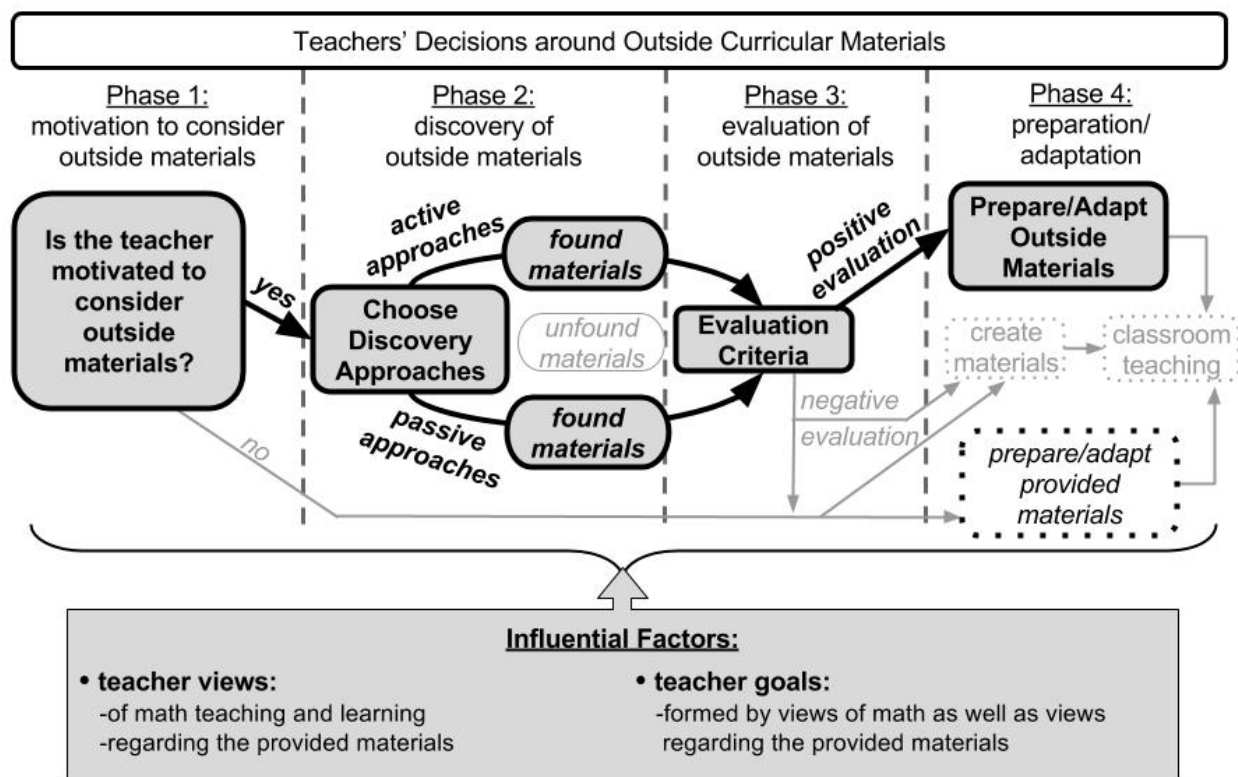


Figure 18. Research framework: Focused on the content of interviews (shown in black).

In the remainder of this section, I show how the framework can be used to understand a variety of teacher decisions by tracing the curricular decisions of the three focal teachers described in chapter 5. To support the exposition, I modify aspects of the representation contained in *Figure 18*, adding specific details to the figure, and deleting aspects of the figure that are unnecessary for describing particular teachers' decisions. I also add recursive arrows to illustrate two aspects of the process that are likely to influence or reinforce a teachers' motivation for considering outside materials in the first place: teachers' prior knowledge of outside materials and teachers' experiences with the outside materials during classroom teaching.

Linda: Active search to fulfill both general and specific motivations. Linda viewed structured practice as important for students' math learning, felt the provided materials were dull and lacking in practice opportunities, and viewed engagement as occurring when students could interact with fun materials. These views influenced her decision process (represented in *Figure 19*), including both her general motivation to incorporate interactive elements into her lessons and her specific motivation to replace activities in a specific lesson that she found boring and limited in options for practice (Phase 1 in *Figure 19*). Her choice of discovery approach was

based on prior experience with Pinterest, which includes many interactive and visually engaging curricular materials (Phase 2 in *Figure 19*). Additionally, she knew that Pinterest would be a useful way for finding the type of curricular material she already knew that she wanted: an interactive Smart Board lesson. In this way, knowledge of a type of outside material (Smart Board lessons) may have influenced her motivation to replace her provided activities in the first place (illustrated by the arrow leading from Linda’s outside materials to her motivation to consider outside materials). When she discovered the outside material that she ended up using, she immediately gave it a positive evaluation because it met her criteria of being interactive and fun, and she decided to use it because it met her other important criteria of offering practice and being aligned with her provided lesson (Phase 3 in *Figure 19*). Linda’s tailored approach to discovery (using search methods and search terms known to be useful) and her use of evaluation criteria that were tightly aligned with her goals allowed her to engage in minimal preparatory activities, because in her perception, the materials were already a perfect fit (Phase 4 in *Figure 19*). Although no data were collected during Linda’s classroom teaching, her responses made it clear that her enactment of the lesson (in which students were happy about the fun materials and asked to play the song repeatedly) reinforced her initial motivation to include interactive materials (illustrated by the arrow leading from Linda’s classroom teaching back to her motivation to consider outside materials).

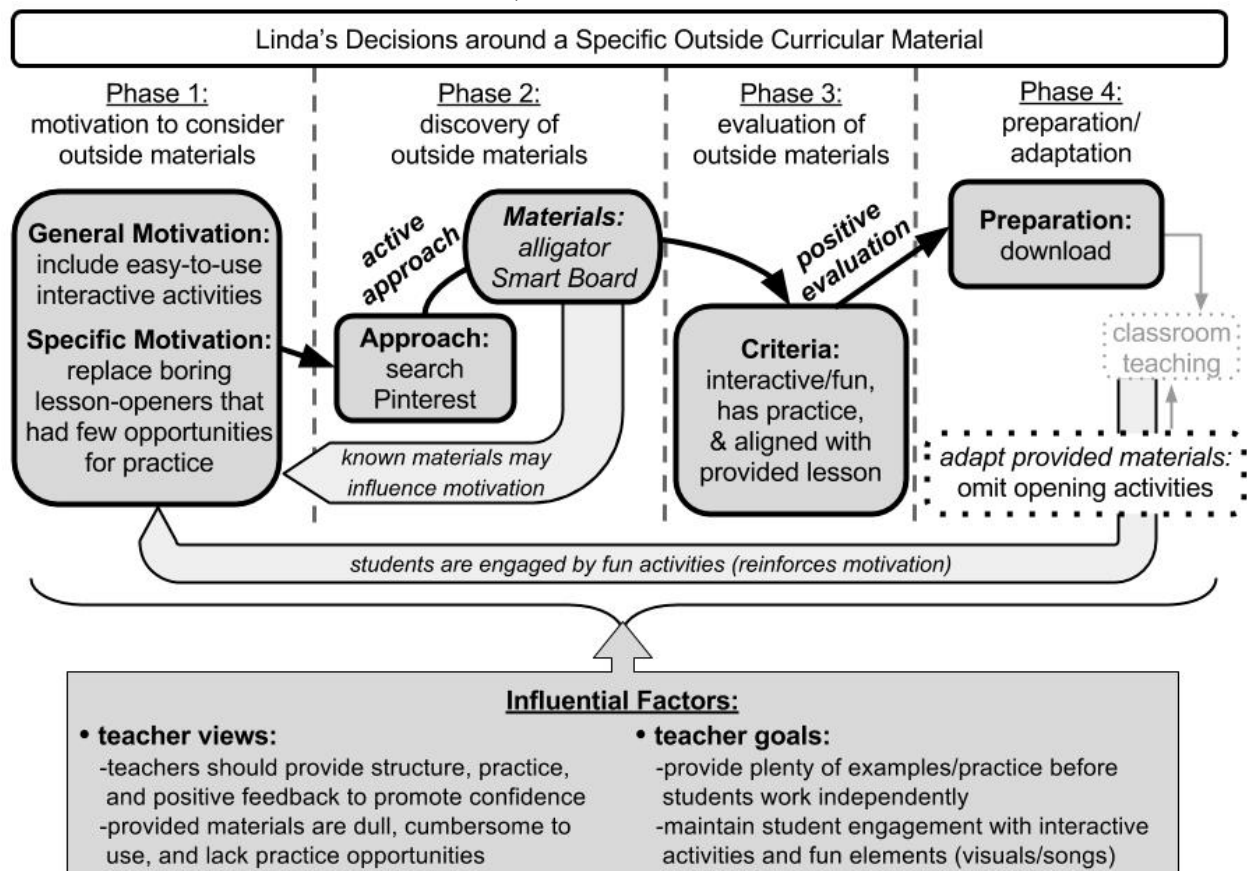


Figure 19. Tracing Linda’s decisions around outside materials through the framework.

Gene: Passive discovery of non-instructional material. Gene viewed math as a tool for learning about the world, felt the provided materials included too many fictitious scenarios, and viewed engagement as occurring when students had access to high-interest “real-world”

situations. These views influenced his decision process (as represented in *Figure 20*) and motivated him to incorporate real-world connections whenever he could (see Phase 1 in *Figure 20*). Because this was a general motivation rather than something prompted by a specific lesson, Gene’s discovery approach was a passive one: He simply kept his mind open to the instructional possibilities of things he encountered in his day-to-day life, including his morning newspaper (Phase 2 in *Figure 20*). When he came across the article on Inky the octopus, he found the idea of an octopus escaping an aquarium to the ocean interesting. As he continued to read, he noticed that the article included several linear measurements and thus identified the article as a potential curricular material (given his knowledge of grade-level standards on linear measurement). He decided to use the article due to his positive evaluation that it would also be interesting to his students, that it was a true story, and that it was related to an upcoming unit on measurement (Phase 3 in *Figure 20*). Gene’s approach to discovering outside materials in his day-to-day life was well suited to his goal of incorporating real-world connections, and resulted in discovery of a material that required minimal preparation (Phase 4 in *Figure 20*). Although no data were collected during Gene’s classroom teaching, he recalled that months following the lesson, a student made a spontaneous connection between the real-world situation described in this outside material and their marine biology content during science. Gene reported that this student-led connection was important to him, and indicates that this reinforced his initial motivation to include high-interest real-world scenarios (illustrated by the arrow leading from Gene’s classroom teaching back to his motivation to consider outside materials).

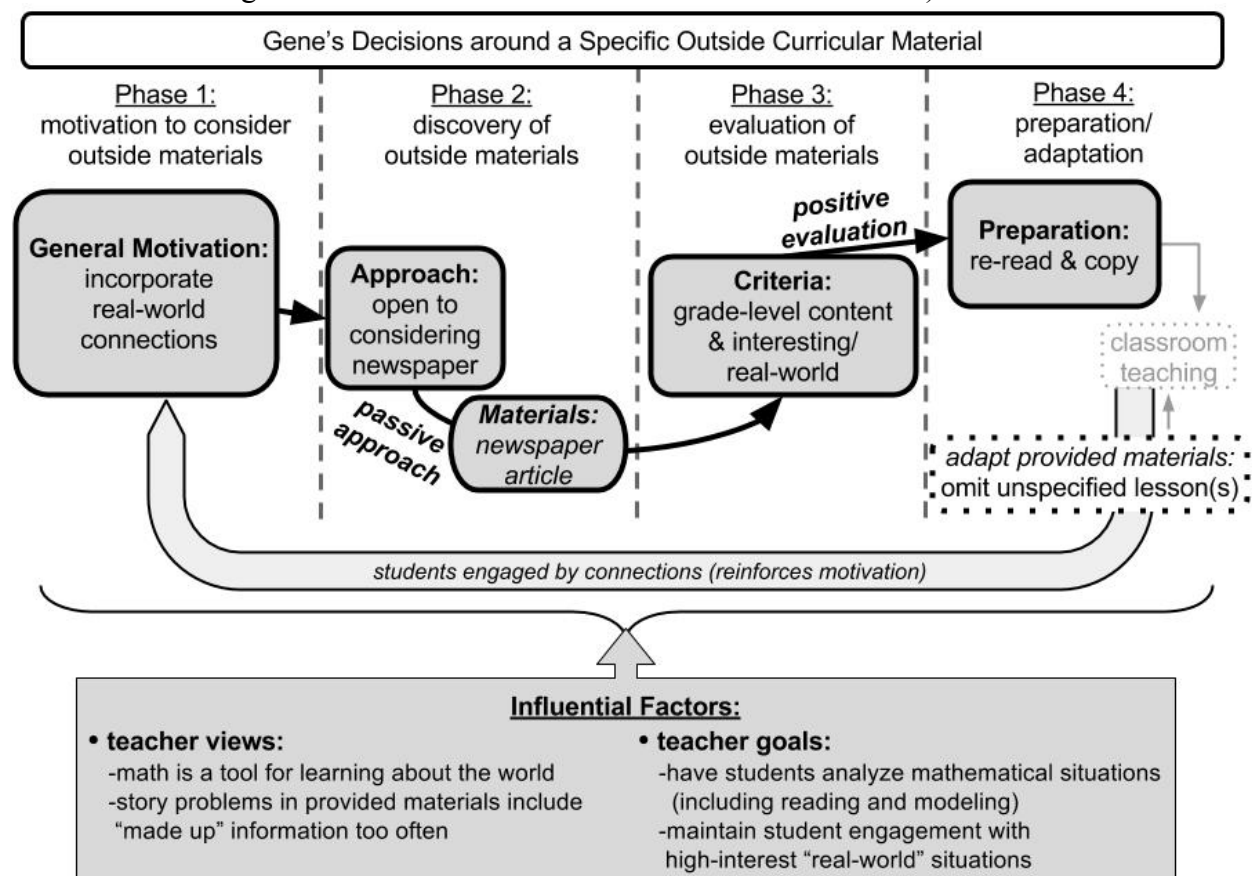


Figure 20. Tracing Gene’s decisions around outside materials through the framework.

Tina: Already-discovered materials retained in curricular library. Tina viewed grappling with challenging problems as important for students’ math learning, felt the provided materials offered few opportunities for students to construct their own knowledge, and viewed engagement as occurring when students stretch their thinking during rigorous tasks. These views influenced her decision process (as represented in *Figure 21*), motivating her to replace the provided math talks that were often close-ended and not very rigorous. Instead, she incorporated open-ended mathematical discussions that provided opportunities for students to construct their own mathematical understandings (Phase 1 in *Figure 21*). Tina had previously discovered materials that she evaluated as meeting this need (Number Talks), and by retaining them in her curricular library they were readily available (Phase 2 in *Figure 21*). As described in chapter 5, Tina’s knowledge of the alternative offered by Number Talks may have influenced her to evaluate the provided materials more harshly, and thus increased her general motivation to include outside mathematical discussions (illustrated by the arrow leading from Tina’s outside materials to her motivation to consider outside materials). Because Tina used outside materials that she already knew about, her evaluation occurred in two steps; the initial general evaluation that Number Talks was aligned with her goals, and the subsequent specific evaluations of particular prompts in order to select the appropriate difficulty level for her students (Phase 3 in *Figure 21*). Tina’s preparation for using her outside materials also involved a general step (establishing classroom norms regarding mathematical discussions) and a specific step (anticipating students’ misunderstandings), thus her preparation activities were also unique among focal teachers (Phase 4 in *Figure 21*).

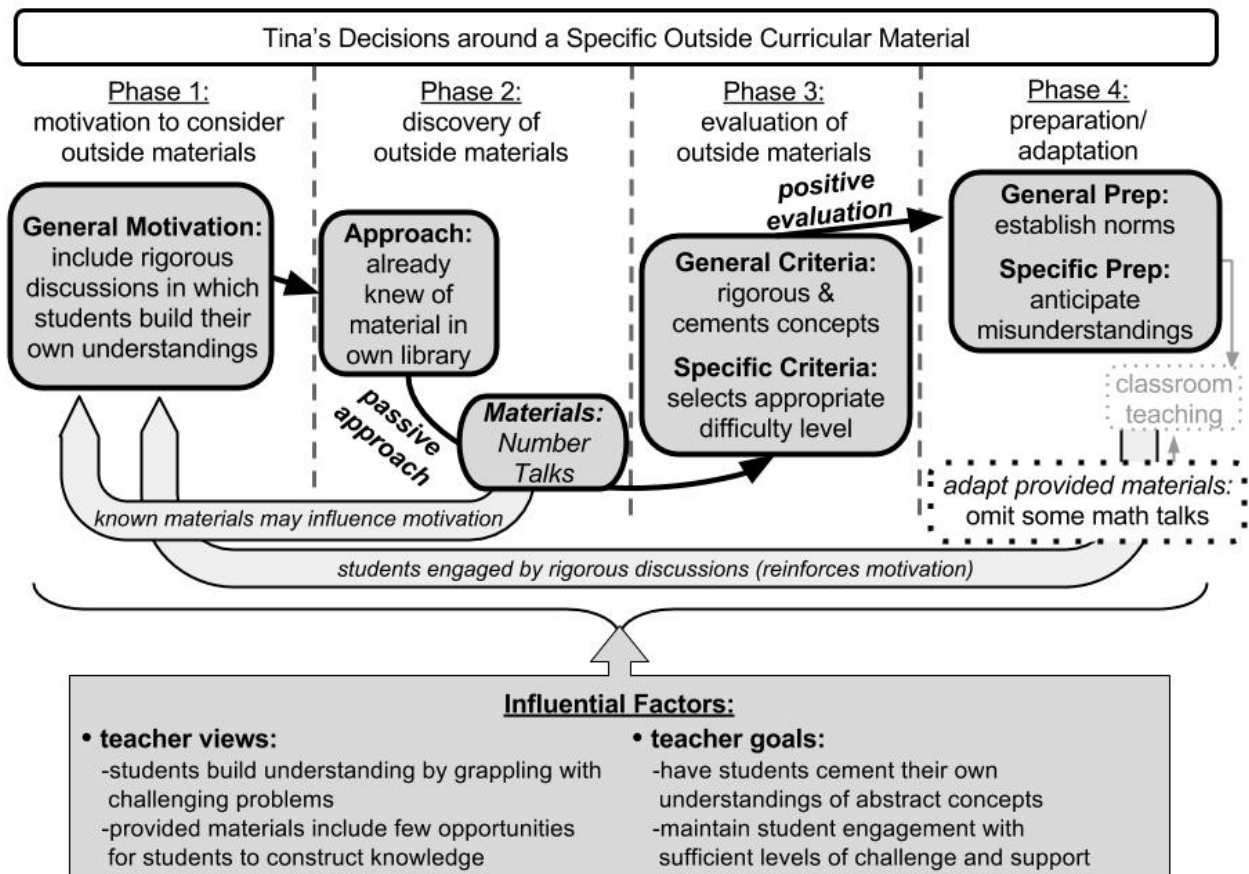


Figure 21. Tracing Tina’s decisions around outside materials through the framework.

Although no data were collected during Tina's classroom teaching, she reported that these accessibly rigorous discussions engaged her students and helped them construct their own mathematical understandings, thus reinforcing her initial motivation to include this outside material (illustrated by the arrow leading from Tina's classroom teaching back to her motivation to consider outside materials).

Concluding comments on the research framework. Tracing the decisions of individual teachers through the framework highlights common aspects of seemingly dissimilar decisions, brings important differences among individual decisions into focus, and clarifies the overlapping and interrelated nature of the four decision phases. Although the decisions represented in Figures 19, 20, and 21 are diverse, they are similar in that they all include decisions in each of the four phases, tight connections among teachers' views of math and their motivation to consider outside materials, and post-enactment evaluations that reinforce that initial motivation. Comparing these figures also highlights ways in which teachers' individual decisions diverge from the general framework. For example, while most teachers described only specific evaluation criteria and preparation activities, Tina's decision to use an already-known material included both general and specific elements of the evaluation and preparation phases. Finally, these figures illustrate that although the distinction between the four phases is useful, teachers' decisions do not proceed in a linear fashion, and there are no clear breaks between each phase. Teachers' evaluation criteria in particular span across the phases, as their criteria are tightly linked to their initial motivation to consider outside materials, they engage in preliminary evaluations during the discovery process, and they engage in subsequent evaluations after using the material in their classroom teaching. Thus the use of a dotted vertical line between each phase in the framework is intentional: although considering each phase separately is useful for highlighting commonalities and differences, the phases are actually not entirely separate from one another.

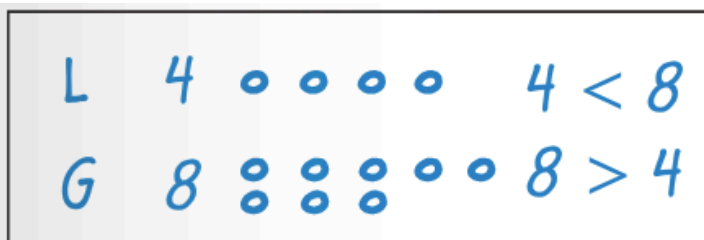
Critical Examination of a Focal Teacher's Decisions and Materials

In this section I return to the decisions of one focal teacher and take a critical lens to her descriptions of her decision-making. I focus specifically on Linda's decisions because unlike the other two focal teachers, Linda was able to pinpoint the specific provided materials that she replaced with her outside materials (Gene and Tina spoke more in generalities). Linda's case allows for a direct comparison of the areas in which she found the provided materials lacking and the ways in which she described her outside materials as improving upon those deficiencies. This closer examination of Linda's provided materials reveals two important considerations: (1) her negative evaluations of the provided materials may have been overly harsh (downplaying or skipping over positive elements and highlighting negative elements), and (2) her use of outside materials may not have been as aligned with her provided materials as she intended. Unfortunately, any critical examination of Linda's decisions is complicated by the lack of a follow-up interview and the lack of access to her actual enactment of the lesson. This interferes with the ability to conclude whether Linda did not attend to positive aspects of the provided materials or if she did notice these features but found them limited. Nevertheless, additional attention to her provided materials does offer some insights into her decisions.

Linda's negative evaluation of her provided materials. Linda cited several reasons for negatively evaluating her provided lesson and replacing its opening activities with outside materials, however closer examination of the provided materials suggest that the lesson included affordances she may not have noticed. Specifically, Linda reported that the provided materials did not thoroughly introduce the greater than and less than symbols, did not provide enough

practice prior to independent work, and did not include elements that made it interactive for students and easy for her to use. In the remainder of this section I will use evidence from the provided materials to examine each of these claims and determine if they are consistent with the full range of resources available in the provided materials.

One of the reasons Linda evaluated the provided materials negatively, is that they only briefly introduced the greater than and less than symbols. At first glance, this is an accurate evaluation, because the particular provided lesson she adapted simply says, “Discuss what children know about comparing numbers and the symbols that mean is greater than, is less than, and is equal to. [...] Have volunteers come to the board to use symbols to compare 11 to 12, 12 to 12, and 12 to 13” (Fuson, 2013a, p. 348). However, a closer examination of the provided materials shows that this lesson (Unit 4 Lesson 12) is not intended to be students’ first introduction to these symbols. The first lesson to explicitly use these symbols is intended to occur several days earlier (Unit 4 Lesson 3), and text from that lesson indicates that even this is not students’ first exposure to the symbols, as it states: “Write the symbols =, <, and > on the board. Children have seen them in Daily Routine activities” (Fuson, 2013a, p. 290). During interviews, no teachers mentioned the Daily Routine activities, which are explained in the introduction to the teacher edition and mentioned in brief notes in the corner of each lesson’s introductory page. Therefore it is possible that Linda did not notice these activities, which would explain why she was dissatisfied with the brief overview in the lesson she adapted. Given Linda’s general evaluation of the provided materials as boring for her students, it is also possible that Linda may have intentionally omitted this repeated provided activity (shown in *Figure 22*) in favor of a single highly engaging outside activity to introduce the greater than and less than symbols.



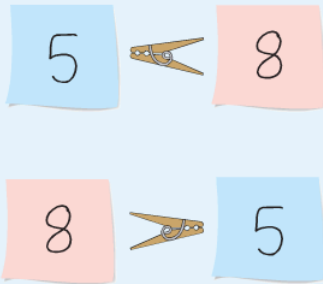
Discuss how to find which number is greater and which number is less.

Figure 22. The “Daily Routine” which introduces inequality symbols (Fuson, 2013a, p. xxxiii).
Note. Two students are asked to each model a number with circles on the board. They then write an “L” for the lesser number, a “G” for the greater number, and then write the inequalities.

In addition to this repeated exposure to the greater than and less than symbols, the provided materials also included several notes acknowledging that students often have difficulty distinguishing between the symbols, and offering tips for teachers to use. For example, in the initial lesson on the symbols, a note in the margin says: “One simple method is to remember that the small end of each symbol points to the lesser number, and the large end points to the greater number (Fuson, 2013a, p. 290). Additional tips were provided under the frame of “Differentiated Instruction” as shown in *Figure 23*.

Differentiated Instruction

Extra Help Use clothespins and posterboard to create this visual display to help children see the difference between the “is greater than” and “is less than” symbols.



Have children write numbers on sticky notes and place them correctly.

Differentiated Instruction

Special Needs If children consistently confuse the inequality symbols, give children an index card with the symbols on the card. For example:

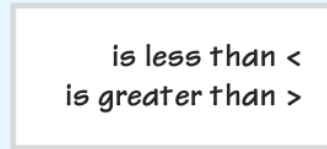


Figure 23. Tips on greater than and less than symbols in Linda’s provided materials.

Note. Left side is from the initial lesson with greater than and less than symbols (Fuson, 2013a, p. 290); Right side is from the lesson adapted with outside materials (Fuson, 2013a, p. 348).

It is unclear whether Linda noticed these tips, or found them useful for her students. However, given her focus on materials that are visually engaging and fun for students, it is unlikely that she would have found the provided suggestions to use post-its, clothespins, and index cards as engaging as her outside material which involved cartoons and a song.

Linda also evaluated the provided materials negatively for providing limited opportunities to practice. While reviewing the provided lesson, she reported that she felt the need for something “more substantial” before students were “expected to go on their own” with independent work. At first glance, this evaluation is consistent with the provided materials’ use of only two examples for comparing pairs of two-digit numbers. However, a closer examination shows that directly after the second example, the teacher edition says, “Continue comparing several pairs of 2-digit numbers. Include examples that use the equal sign” (Fuson, 2013a, p. 348). It is unclear whether Linda did not notice this suggestion (perhaps it got lost among all the other text on the page) or if she evaluated this suggestion negatively because it required her to come up with number-pairs on the spot (a task that may add to the difficulty of using the provided materials). In either case, her outside materials do appear to address this area of dissatisfaction well, given that they met her need for more examples, the provided’ materials’ directive to include examples using the equals sign, and her suspected preference for pre-determined number-pairs.

Linda’s biggest areas of dissatisfaction with the provided materials were that they were boring for students and cumbersome for her to use. Her solution to both of these issues was to replace the opening activities with an interactive whiteboard lesson that supported her seamless presentation of tasks (i.e., she did not have to put her head in a book) and that also provided a fun, visually engaging, and interactive experience for her students. At first glance, this evaluation is consistent with the provided materials’ text-heavy teacher edition and use of simple numerals on the board rather than the engaging pictures and song of her outside materials. However, a closer examination of the provided materials shows that each lesson comes with a

corresponding interactive white board component designed specifically to support the provided lesson. It is unclear whether Linda was unaware of these resources or if she found them lacking, however given that she described a common effort among her grade-level team to find, create, and share Smart Board lesson openers, it is likely that she was aware of this pre-made alternative, but that she (and her team) did not evaluate these provided resources highly. Additionally, examining a sample interactive whiteboard resource shows that it is intended to supplement but not replace the use of the teacher edition (e.g., it offers digital tools to model mathematical situations, but the situation-descriptions are only present in the teacher edition, not in the slides). Thus although the provided materials intended to include an interactive component, it did not meet all of Linda's needs, as it still called for teachers to read text-heavy descriptions of activities in the teacher edition

This close attention to the provided materials reveals that in some ways Linda's negative evaluations were not fully justified. The provided materials did provide more introduction to the greater than and less than symbols than she described, the lesson did suggest including multiple opportunities to practice (more than the two she noted), and the materials also include an interactive whiteboard resource (which was the type of outside material she specifically searched for). However at the same time, there are ways in which Linda's negative evaluations of each of these elements is well founded. The provided introductions to the greater than and less than symbols were spread throughout the provided materials, requiring coordination of multiple components and close adherence to the lesson sequence. Also, although the materials acknowledged that students often have difficulty distinguishing between the symbols, the suggested supports offered little in the way of engagement (viewed by Linda as something fun and interactive). Also, the provided opportunities to practice required the teacher to choose number pairs on the spot, and the provided interactive whiteboard was only useful in conjunction with the cumbersome teacher edition. This, in addition to Linda's evaluation of her chosen outside materials as incredibly fun and engaging for her students, suggests that her outside materials were well suited to make up for the deficiencies she identified in her provided materials.

Misalignment between Linda's outside and provided materials. Although there are many ways in which Linda's negative evaluation of her provided materials was justified, elements of misalignment between her provided and her outside materials raise additional concerns. Linda reported that maintaining close alignment with the provided materials was one of her goals, and that her choice of outside materials helped her do that. However Linda's provided lesson placed a clear emphasis on using place value to compare numbers, while her outside material did not include such explicit attention. The title of Linda's provided lesson was "Use Place Value to Compare Numbers," and it included an explicit note that students should understand: "When comparing 2-digit numbers, compare the tens digits first. If the tens are the same, then compare the ones" (Fuson, 2013a, p. 348). The materials supported this by including number pairs that would facilitate this comparison (i.e., comparing 34 to 43 and 35 to 37), however the materials did not make explicit mention of the utility of these specific number pairs, nor did it offer suggestions for how to choose worthwhile pairs once teachers were directed to choose their own. In contrast, Linda's outside materials were saved with the filename "Greater Than Less Than Smart Board," and only mentioned place value once (on an introductory teacher-focused slide when quoting the content standard). This is not to say that Linda did not attend to place value during her teaching, only that there is a clear difference in emphasis of this important content standard between the two materials. Despite the lack of explicit attention to place value in the outside materials, the included number pairs do offer multiple opportunities to

make these comparisons (e.g., comparing 27 to 45 and 45 to 41). Without data on Linda's actual classroom enactment, it is impossible to tell whether or not her use of outside materials resulted in misalignment with the provided materials. She may have added explicit attention to place value during her teaching, spurred by the standard listed on the materials' introductory slide, the notes from her provided teacher edition, or her years of experience with teaching first grade.

Impact of cumbersome materials. Linda disliked the teacher edition for being too text-rich and cumbersome to use. She cited this as a reason for skipping the specific provided lesson openers she discussed during her interview. However, her negative evaluation of the provided materials may have also impacted her use of earlier lessons and routines that were intended to introduce the greater than and less than symbols. Given that Linda preferred not to read from lessons in the teacher edition, it is unlikely that she would have flipped back into the introduction section in order to use the Daily Routines that introduced the greater than and less than symbols. Therefore, although her critique of the provided lesson as providing insufficient introduction to the symbols was not technically accurate (it was not the introduction to the symbols but rather a reminder), her critique could be interpreted as additional evidence that the provided materials are difficult to use. By being too text-rich and including resources spread out over multiple books and sections of books, the provided materials may have obscured important aspects of the lessons and lesson-sequences. This may lead teachers to miss these important elements, particularly if they choose to adapt the lessons by incorporating outside materials. Although further research is needed, the impact of cumbersome provided materials on teachers' decisions has potentially important implications for curriculum developers, which will be discussed in the implications section below.

Limitations

This study aimed to provide a first step in exploring elementary teachers' decisions around outside curricular materials in mathematics. Although the design of this study was well suited to exploring multiple research questions in this underexplored area, several features of this study's design and execution limit its ability to draw definitive conclusions regarding teachers' use of outside materials. In this section I focus on describing limitations that impact interpretation of the current findings and that provide implications for future research. Specifically, I describe limitations related to the study's retrospective self-report design, specific survey items, and the number of district contexts.

Design: Retrospective self-report interviews at a single time point. A primary limitation of this study is that it only involves teachers' retrospective self-report at a single time point, with no data on teachers' in situ curricular decisions, classroom enactment of materials, or responses to questions raised by a critical analysis of their curricular decisions. This design was useful in that survey results provided a first look at how many teachers consider using outside materials, and interview results provided a first look at how teachers describe their decisions in relation to specific outside materials. However, this study's reliance on self-report at a single time point leaves several open questions. Here, I describe limitations that arise from this study's lack of four features that should be incorporated into future research: follow-up teacher interviews, prospective access to decisions and classroom teaching, input from other school and district personnel, and data on student outcomes.

First, although the teacher interviews provided rich descriptions of teachers' decisions, the lack of follow-up interviews in this study precluded any opportunity to further probe teachers' curricular decisions following a critical analysis of their materials. Without any follow-up, it is unclear whether teachers did not notice certain features of their provided

materials, or if they simply evaluated those features as not important or as ineffective. This limited options for critically examining teachers' decisions. For example, the current study cannot address whether or not Linda noticed her provided lesson's focus on place value and its associated interactive whiteboard. Her omission of these features may have been because she saw them as unimportant or not useful, or she may have missed them while skimming through the text-rich teacher edition. Future research should include follow-up interviews in order to add depth to teachers' critiques of their provided materials. This will also help guide implications for curriculum developers who could use details from follow-up interviews to remove less useful features and highlight essential elements.

Second, the current study includes only retrospective self-report without access to teachers' actual decisions regarding discovery, evaluation, preparation, and use of outside materials. This makes it unclear whether or not teachers' decisions regarding the provided and outside materials proceeded in the ways they reported. In addition to the simple errors in translation when trying to understand an interactive activity via verbal descriptions, as well as potential errors in recall, prior research that includes data from teachers' enactment of curricular materials shows that teachers sometimes make unintentional adaptations and omissions during teaching (Sherin & Drake, 2009). Therefore, future research should include opportunities to observe teachers during lesson planning as well as during teaching. Such research would offer more detail on teachers' decisions around outside materials, and may even reveal different patterns in decisions.

Third, the current study includes data only from individual teachers spread across grade levels and schools. This leaves out many potentially important aspects of the contexts in which they make decisions, including the influence of teacher colleagues, principals, district math specialists, and district curriculum department members. Each of these groups may support or constrain teachers' decisions in ways that were not fully explored by this study. For example, some teachers mentioned a desire to stay in alignment with their grade level team members (sometimes sharing outside materials in order to do so), while others did not. Future research could include attention to teachers' planning within grade-level teams in order to identify factors related to collaboration that may influence teachers' decisions around outside materials. Additionally, research should include the perspective of non-teaching personnel such as principals and district math/curriculum specialists in order to better understand the contexts in which teachers make curricular decision.

Finally, although it was outside the scope of this dissertation, the lack of student data and an experimental or pseudo-experimental control makes it impossible to determine how teachers' decisions to use outside materials impacted student outcomes. In general, the use of outside materials is conceptualized as neither inherently positive nor negative for students. However, specific types of decisions around outside materials are likely to have tradeoffs among various important student outcomes. For example, in Gene's class—in which he diverged from the provided sequence in order to incorporate real-world connections—students may be more likely to view math as a useful tool for understanding the world. However, comparison to classes in which teachers strictly followed the pacing guide would help establish whether or not this is the case, as well as whether or not Gene's decisions led to disjointedness that negatively impacted his students' understanding of content in the omitted provided lessons. Therefore, future research should attend to a wide variety of student outcomes. This should include academic outcomes (gains in both procedural knowledge and conceptual understanding) as well as

outcomes related to a variety of teacher goals (such as the goal of seeing math as fun or seeing themselves as mathematicians).

Design: Specific survey items. After analyzing results of the study, I noted two limitations of survey items: first, questions regarding teachers' years of experience with their provided curriculum may have been confusing and too general, and second, questions regarding teachers' approaches towards discovering outside materials may have been biased towards active approaches.

Teachers were asked to report their years of experience with the provided curriculum, however analyses revealed three limitations of this seemingly simple survey question: the question was overly vague (failing to specify between editions of the provided curriculum), the question lacked important memory aids (potentially leading to inaccurate reports based on teachers' misremembering the year of district adoption), and the question was overly general (failing to specify experience with current grade level). As described earlier, Glencrest teachers may have answered this question differently depending on whether or not they viewed the Common Core updated version of the provided materials as the same curriculum or a new curriculum. Teachers may also have simply made errors in their recollection of how long ago their district adopted a curriculum. These limitations point to a need for future research to create district-specific surveys that specify which edition of the provided materials are being referred to (e.g., all versions or the most recent update), and that include relevant details about when the district initially adopted the provided materials (so as to reduce measurement error arising from misremembering). More importantly, future research should specifically ask teachers to report their years of experience with a provided curriculum at their current grade level. This is based on the report from several teachers during interviews that their use of the provided materials changed depending on their level of experience with the specific standards and lessons for their grade. They described additional adaptations as they gained experience with their grade, and that when they switched to a new grade (even using the same overall curricular program) they tended to engage in fewer adaptations of the provided materials in order to gain familiarity with the unique attributes of that grade level. Therefore teachers' experience with a particular provided curriculum at a particular grade level is expected to be more influential on their decisions than their experience with the provided curriculum in general.

Teachers were also asked to describe how frequently they used a variety of different discovery approaches, and then to choose which single approach they used most frequently *or* they found most useful. Results from the survey suggest that teachers primarily use active approaches towards discovering outside materials. However results from interviews—in which teachers discussed a single well liked outside material in depth—showed a surprising array of passive discovery approaches. There are several reasons why the passive approaches described in the interview may not have been fully captured by the survey. First, most of the options listed in the survey were active approaches. Second, teachers may not have made a clear distinction between similar active and passive approaches when giving their responses (e.g., a teacher who happened to hear about an interesting outside materials while talking with her grade-level colleagues may have reported this as an instance of “asking another teacher”). Third, because the interview focused on a single outside material, interview results do not necessarily capture teachers' most frequently used approaches, but rather interview responses may have been more likely to reveal discovery approaches that led to particularly well-liked or useful outside material. This would be expected if approaches that were used frequently due to convenience (e.g., internet searches) tended to reveal only moderately well-liked outside materials and if

approaches that were used infrequently due to scarcity (e.g., limited access to a district math specialist) or expense (e.g., conferences) tended to reveal outside materials that were evaluated very highly by teachers. Thus future research should attempt to separate measures of how frequently teachers use various approaches from measures of which approaches led to the most well liked outside materials

Execution: Limited number of district-contexts. This study is also limited by the fact that it includes survey data from only two districts, and interview data from only a single district.¹⁸ The district context encompasses many variables that relate to teachers' curriculum use—from student demographics, to district policies on curriculum use, to the provided curriculum itself. Because findings from this study come primarily from a single district (approximately four times as many survey respondents from Glencrest as from Westbluff), they are limited to describing how teachers consider outside materials in an affluent, high achieving district that expects teachers to use Math Expressions with some room for professional judgment. Thus future research should pay particular attention to teachers' use of outside materials in settings with low student achievement, with different policies on curriculum use (from strong expectation of very little adaptation to full freedom to adapt), and with different provided curricular programs. This will add to our understanding of which patterns persist regardless of district (e.g., the general finding that teachers consider outside materials due to dissatisfaction with their provided materials), and which findings are specific to district context (e.g., the specific finding that Glencrest teachers identified a need for differentiation and a need for more engaging activities.).

Implications

This dissertation began with open questions on how teachers make decisions around outside curricular materials, an underexplored area in research on teachers' practices. The limitations described above notwithstanding, this work makes several contributions that have implications for a variety of audiences. Here I describe some of the main implications for curriculum developers and school districts, and highlight a few important next steps for researchers.

Implications for curriculum developers. Results from this dissertation indicate that lower teacher-ratings of the effectiveness of their provided materials were correlated with a higher frequency of considering outside materials. Even so, many teachers who reported being mostly satisfied with their provided materials *still* frequently considered outside materials to make up for specific areas they found deficient. This suggests that when evaluating and revising curriculum, developers should pay specific attention to areas that motivate teachers to consider outside materials, as this may be a particularly useful way of identifying areas for revision that may be glossed over in response to a more straightforward question about overall satisfaction with materials.

¹⁸ Many districts were contacted to gauge interest in this study; several did not reply, one declined before reviewing the research proposal, one experienced personnel changes that delayed a review of the proposal, and six districts (in addition to the two included in this study) reviewed the research proposal but declined to participate. Of the six districts that declined after reviewing the proposal, three declined to participate due to concerns about adding any additional demand on teachers' time, and three declined because they were in the process of adopting a new math curriculum and were concerned that an external survey would interfere with internal efforts to evaluate math curriculum use. Thus although proposal materials were designed to illustrate how results of this study could inform curricular adoption efforts, district responses indicate that the study was more appealing to districts that had recently adopted new curricular programs.

Contrastingly, the results also suggest that pinpointing specific areas for revision may still leave many teachers seeking outside materials due to difficulty navigating a comprehensive and text-rich curricular program. Multiple teachers reported difficulty using the teacher edition and coordinating various components, which often motivated them to replace significant portions of lessons. This suggests that curriculum developers may want to consider a new format for curricular programs entirely, perhaps based on the suggestion given by Teacher 6 to include a bullet-point version of the teacher edition to use during teaching, with an accompanying reference text to use during planning. Given that teachers would still be likely to incorporate outside materials to align with their views of math teaching and their students needs, this streamlined approach has the potential to allow important elements of the provided materials rise to the forefront, and therefore decrease the chance that teachers would introduce unintended areas of misalignment when using outside materials (such as is suspected in the case of Linda).

Implications for district curriculum and instruction departments. The results of this study show that even in a setting in which teachers report they are expected to use their provided materials, they still frequently use outside materials to make up for deficiencies and align with their views of math teaching. For districts that want to promote consistency of instruction across schools (whether motivated by alignment with standardized tests, support for a mobile student population, or other reasons), the curriculum and instruction department should take areas in which teachers have identified needs for outside materials seriously. Rather than imposing additional external control on teachers to enforce fidelity with the provided materials, districts could use the results of this study to take an approach that acknowledges teachers' needs and the deficiencies of the provided curricular program. Allowing for professional judgment (as teachers report that Glencrest does), is a first step, but specifically surveying teachers' use of outside materials is likely to provide many additional benefits discussed below, specifically: (1) the ability to provide additional training or support, and (2) the ability to capitalize on the discovery, evaluation, and adaptation work that teachers have already done.

First, by surveying teachers' use of outside materials, districts could identify areas (either specific lessons or general features) that are not meeting teachers' needs. This could motivate the district to provide additional information or training on available features of the provided materials that might have been overlooked, such as the interactive whiteboard resources that may have met some of Linda's needs. Alternatively, this type of survey might alert the district to true gaps in the provided curriculum, such as insufficient support for priming the background knowledge of ELL students, as Teacher 7 identified. The benefit in asking teachers about their use of outside materials, rather than simply the areas of the provided materials that need improvement, is that teachers are already seeking out ways to address these gaps. However, as in the case of Teacher 7 who identified the AIMS4S³ anchor charts as a potential solution to her need to support ELL students, teachers may not have sufficient training or support to use these materials effectively. Thus, if many teachers across the district also identified a need to support ELL students, a survey of outside material use could help amplify Teacher 7's request for training in order to use her outside material effectively.

Second, by attending to teachers' past discoveries of outside materials, districts could access a wealth of untapped resources that are already present in the district. If a district were to survey teachers and identify materials that teachers have already discovered, evaluated, and used in their classrooms, the district curriculum department could promote more widespread sharing of relevant resources that maintain alignment with district goals and standards. This district-specific approach to sharing would offer benefits beyond those offered by existing national

websites for sharing materials (e.g., Pinterest and Teachers Pay Teachers), as teachers within a district are adapting the same set of provided materials in order to serve similar sets of students, and thus are likely to face common challenges. For example, it is unlikely that Linda and her colleagues were the only teachers looking for more interactive and fun materials for their first graders. By moving from sharing materials among schools or among grade level teams, to sharing materials at the district level, teachers would gain access to materials discovered by a wide array of teachers. If districts were to include options for commenting, editing, and other means of active collaboration, this would provide additional opportunities for district specialists or other teachers to edit outside materials in ways that maintain their unique affordances, but also retain alignment with essential content standards (e.g., a math specialist might agree that Linda's outside Smart Board offers a much needed opportunity for fun, and simply tweak the materials by adding a line to encourage attention to place value during problem solving).

Implications for researchers. Past research on teachers' use of provided curricular materials has greatly enriched our understanding of how teachers make decisions to reach their professional goals; this dissertation makes the case that math education research should continue with research on teachers curricular decisions, but with the inclusion of outside materials. Specifically, research programs that document the extent to which teachers use, adapt, and omit provided materials throughout the school year provide rich data sets without the drawbacks of retrospective interviews, and offer a fruitful area for next steps. By including a focus on teachers' use of outside materials, researchers may uncover unique patterns in how a teacher's style of using provided materials might coincide with their style of using outside materials. For example, several teachers in this study reported that they used nearly all of the provided materials, simply adding on bits and pieces with outside materials. Future research could determine whether these statements accurately capture their practices, and whether these decisions differ in important ways from teachers who reported a tendency to replace significant portions of provided materials with outside materials.

Additionally, new research programs should build off this dissertation in order to continue to add depth to the research base on outside materials. High priority goes to studies that expand the variety of district contexts, particularly to districts with lower student performance on standardized mathematics tests. Teachers in Glencrest, with high student performance, reported a need to differentiate for students performing both above and below grade level. Attention to districts with a larger proportion of students performing below grade level might simply reveal a stronger trend towards "adapting down" for those students, but it might reveal unexpected and creative ways in which teachers discover, evaluate, and use outside materials to meet the unique needs of their students. Priority should also be placed on broadening methods away from retrospective surveys and interviews, and into yearlong (or even multi-year long) combinations of teacher interviews, classroom video, and student data. Data from this dissertation suggest that these types of studies would be particularly enriched by the inclusion of the work of teacher communities, as several teachers referenced collaboration with their grade-level teams, and by the inclusion of multiple consecutive school years. This would allow researchers to trace changes in teachers' decisions related both to increases in familiarity with the provided materials (e.g., a teacher in their second year of using a provided curriculum moving into their third year with the same grade) as well as decreases in familiarity with the provided materials (e.g., a teacher with five years of experience with the fourth grade provided curriculum moving into a fifth grade classroom).

Concluding Reflections

This dissertation provided a first step in understanding how elementary teachers made decisions around outside curricular materials in mathematics. Prior research focused primarily on teachers' use of provided materials, leaving other important aspects of teacher decisions underexplored. This study used survey and interview data to show that many teachers frequently considered using outside materials in order to meet their teaching goals and make up for deficiencies in their provided materials. Teachers also used a variety of discovery approaches to reveal potentially useful materials, and evaluated materials highly that aligned with their reasons for considering outside materials in the first place. These tailored approaches to discovery and evaluation resulted in the selection of outside materials that required minimal adaptation. Additional research is needed in order to explore unanswered questions, including investigating which of the findings presented here apply to elementary teachers broadly, and which are specific to the context of the sample. Despite these limitations, the results present a strong case for the inclusion of outside materials in future research on teachers' use of curricular materials, and illustrate how a flexible research framework can be used to aid these investigations. By expanding upon the existing research base to include teachers' decisions around outside materials, this dissertation provides further evidence to emphasize that teachers are not mere implementers of curriculum, but that they actively participate with curriculum in order to reach their professional goals.

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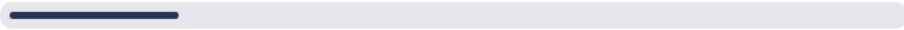
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Appendix A: Survey Questions

The survey was administered in an online format via Qualtrics. Participants indicated their response to multiple-choice items by clicking on the item, and used the keyboard to respond to free-response items. Participants navigated through the survey using “next” and “back” buttons at the bottom of the screen, and bar at the top of the page indicated progress through the survey.

0%  100%



In what grade level(s) are you teaching math in this year?

K
 1
 2
 3
 4
 5

How many total years have you taught that grade? *(count this year as a full year)*



Likert-type items were presented in a matrix with anchors across the top of each column, and items down the left of each row, as shown below:

How frequently did you consider using an outside material due to the following reasons?

	Never for this reason	Rarely for this reason	Sometimes for this reason	Often for this reason	Almost always for this reason
to reduce time required to prepare lesson	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
to provide students with extra review of concepts	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
to provide students with extra challenge	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
to provide students with a more engaging activity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

In the list below, numbered items indicate questions on the survey, lettered items indicate multiple-choice options, and anchors for Likert-scale items are provided underneath questions.

Part 1: Eligibility

1. This school year, do you teach mathematics at least three days each week?
 - a. Yes/No
2. This school year, do you teach only students in grades K through 5?
 - a. Yes/No

If No to either: “Sorry, but you are not eligible to participate in this study. Thank you for your time, and have a nice day!”

Part 2: Confidential Contact and Background Information

3. Please enter your email address (one you check regularly).

This will be used to contact you in the event you are randomly selected as the winner of a gift card, and to potentially schedule an in-person interview.

When your survey responses are downloaded, your email address will be removed and replaced with a numerical identifier.
4. If email is not a reliable way to reach you, feel free to add additional contact information here (e.g., phone number or alternate email).
5. In the interest of maintaining confidentiality, only patterns of responses among groups of teachers at an individual school will be reported. Individual participant responses will not be reported in conjunction with school names.
 - a. What is the name of your current district?
 - b. What is the name of your current school?
6. What is your age?

Part 3: Teaching Career

These questions are about your teaching career:

7. What grade level are you teaching this year?
 - a. K
 - b. 1
 - c. 2
 - d. 3
 - e. 4
 - f. 5
8. How many total years have you taught that grade (as a classroom teacher)? (count this year as a full year)
9. How many total years have you taught at your current school (as a classroom teacher)? (count this year as a full year)
10. How many total years have you been teaching as a classroom teacher in grades K-5? (count this year as a full year)
 - a. 1 (first year)
 - b. 2 (second year)
 - c. 3-5
 - d. 6-8
 - e. 9-11
 - f. 12-14
 - g. 15+

11. Enter the specific number of years you have taught as a classroom teacher in grades K-5:
(count this year as a full year)
12. Are you a special education teacher?

Part 4: Curricular Decisions

These questions are about your decisions regarding curricular materials in mathematics.

Definitions:

- Curricular materials:
 - anything you use to teach a math lesson, activity, or assignment.
 - This could include published curricula, activity/lesson ideas, standalone worksheets, manipulatives, or other materials from any source

Questions will also refer to two subcategories: "provided materials" and "outside materials"

- Provided materials:
 - materials given to you by your school or district for your use this year (this includes "the adopted curriculum," as well as anything else you are expected to use).
- Outside materials:
 - any materials that are ***not*** part of the provided or adopted curriculum for this year, but that you have found from another source.

There are no preferred types of answers here, the purpose of this study is to describe the types of decisions teachers make when using mathematics curricular materials as well as factors that influence those decisions.

13. For this school year, what curriculum did your school or district provide you with?
14. For how many years total have you used or been provided with this curriculum? (count this year as a full year)
15. How effective is the provided curriculum in supporting you in meeting your teaching goals?
 - a. Not effective at all, Not very effective, Somewhat effective, Very effective
16. If you could change ***one*** thing about your provided curriculum, what would it be?

-
17. Please estimate: What percentage of teachers at your school use ***outside*** mathematics materials at each of the following frequencies this year: (Total should equal 100. If you're not sure, please just provide your best guess.)
 - a. For nearly every lesson
 - b. Multiple times per week
 - c. Around once a week
 - d. Once or twice per month
 - e. Once every 2-3 months
 - f. Less than once every 2-3 months
 - g. Never this year

18. *During this school year*, have you considered using curricular materials *for math* that were *not* provided by your school or district?

This could include hearing about something you might like to use, seeking something out to fill a specific need, or using something that you've used in the past, but that is not part of the current provided curriculum.

- a. No, I did not consider using materials other than those provided by my school.
- b. Yes, I considered using a curricular material other than those provided by my school.

If "No," survey skips to Q25, for "Yes," survey continues here:

Reminder of Definitions:

- Curricular materials:
 - anything you use to teach a math lesson, activity, or assignment.
 - This could include published curricula, activity/lesson ideas, standalone worksheets, manipulatives, or other materials from any source
- Provided materials:
 - materials given to you by your school or district for your use this year (this includes "the adopted curriculum," as well as anything else you are expected to use).
- Outside materials:
 - any materials that are *not* part of the provided or adopted curriculum for this year, but that you have found from another source.

19. How frequently have you considered using an outside curricular material for math this year? (Again, regardless of whether or not you ended up using the material.)

- a. For nearly every lesson
- b. Multiple times per week
- c. Around once a week
- d. Once or twice per month
- e. Once every 2-3 months
- f. Less than once every 2-3 months

20. How frequently did you consider using an outside material due to the following reasons?

Scale from 0-4. 0: never for this reason 1: Rarely for this reason, 2: Sometimes for this reason, 3: Often for this reason, 4: Almost always for this reason

- a. to reduce time required to prepare lesson
- b. to provide students with extra review of concepts
- c. to provide students with extra challenge
- d. to provide students with a more engaging activity
- e. to provide students with more manipulatives
- f. to provide students with more practice with procedures
- g. to increase focus on mathematical concepts
- h. Other, please specify.

21. If you had to pick *one* reason that prompted you to consider using an outside material (the most important reason or the reason that prompted you most frequently): what would it be?

(Note: Feel free to select from provided responses or write your own.)

- a. to reduce time required to prepare lesson
 - b. to provide students with extra review of concepts
 - c. to provide students with extra challenge
 - d. to provide students with a more engaging activity
 - e. to provide students with more manipulatives
 - f. to provide students with more practice with procedures
 - g. to increase focus on mathematical concepts
 - h. Other, please specify.
22. Below are some approaches teachers might use to discover outside curricular materials. Considering the instances in which you have discovered outside curricular materials for mathematics (regardless of whether or not you ended up using the materials), how frequently has it been through the following approaches?
- Scale from 0-4. 0: never used this approach, 1: Rarely used this approach, 2: Sometimes used this approach, 3: Often used this approach, 4: Almost always used this approach
- a. Searched through my own collection of curricular materials
 - b. Asked another teacher (in person or via phone/internet)
 - c. Asked a school/district math specialist/coach (in person or via phone/internet)
 - d. Attended a seminar/conference
 - e. Browsed a known website or blog (e.g., a site that you knew had materials)
 - f. Posted a request to a group online (e.g., to Facebook/Twitter/teacher forum/email list, etc.)
 - g. Searched online using generic search engine (e.g., Google)
 - h. Searched online using another approach (e.g., Pinterest, Facebook, etc.)
 - i. Came across via a subscription to a teaching blog, newsletter, or other information feed.
 - j. Came across an outside material at an event (conference or district professional development section)
 - k. Came across an outside material when talking with other teachers
 - l. Other (please describe): _____
23. Which **one** of these approaches did you use most frequently? (or if multiple approaches were used with the same frequency, pick the one that was most useful to you)
- a. Searched through my own collection of curricular materials
 - b. Asked another teacher (in person or via phone/internet)
 - c. Asked a school/district math specialist/coach (in person or via phone/internet)
 - d. Attended a seminar/conference
 - e. Browsed a known website or blog (e.g., a site that you knew had materials)
 - f. Posted a request to a group online (e.g., to Facebook/Twitter/teacher forum/email list, etc.)
 - g. Searched online using generic search engine (e.g., Google)
 - h. Searched online using another approach (e.g., Pinterest, Facebook, etc.)
 - i. Came across via a subscription to a teaching blog, newsletter, or other information feed.
 - j. Came across an outside material at an event (conference or district professional development session)

- k. Came across an outside material when talking with other teachers
 - l. Other (please describe): _____
24. You reported that your most frequent/useful approach to discovering outside math materials was:

_____ *((answer from 23 here))* _____.

Please explain a bit about why you used that approach most frequently, or why it was most useful to you?

If Q18 = "No, I did not consider using materials other than those provided by my school."

Reminder of Definitions:

- Curricular materials:
 - anything you use to teach a math lesson, activity, or assignment.
 - This could include published curricula, activity/lesson ideas, standalone worksheets, manipulatives, or other materials from any source
 - Provided materials:
 - materials given to you by your school or district for your use this year (this includes "the adopted curriculum," as well as anything else you are expected to use).
 - Outside materials:
 - any materials that are **not** part of the provided or adopted curriculum for this year, but that you have found from another source.
25. How important/influential were these potential reasons behind your decision to not consider outside curricular materials.
- Scale from 0-4. 0: Not a reason behind my decision 1: A minor reason, 2: A somewhat important reason, 3: An important reason, 4: A very important reason (Note: Feel free to select from provided responses or write your own.)
- a. the provided curriculum is well-aligned with my student's needs
 - b. the provided curriculum is well-aligned with my teaching style
 - c. adaptation/supplementation is allowed by my school/district, but there is no time because all provided lessons must be covered
 - d. my district administration strongly frowns upon adaptation or supplementation of the provided curriculum
 - e. my school administration strongly frowns upon adaptation or supplementation of the provided curriculum
 - f. my teacher colleagues strongly frown upon adaptation or supplementation of the provided curriculum
 - g. it is my first year using this curriculum and I want to (or have been asked to) try it as written
 - h. Other, please specify. (or feel free to elaborate on another answer choice)
26. If you had to pick **one** reason (the most important/influential) behind your decision to not consider outside curricular materials, what would it be?
- (Note: Feel free to select from provided responses or write your own.)
- a. the provided curriculum is well-aligned with my student's needs
 - b. the provided curriculum is well-aligned with my teaching style
 - c. adaptation/supplementation is allowed by my school/district, but there is no time

- d. because all provided lessons must be covered
- d. my district administration strongly frowns upon adaptation or supplementation of the provided curriculum
- e. my school administration strongly frowns upon adaptation or supplementation of the provided curriculum
- f. my teacher colleagues strongly frown upon adaptation or supplementation of the provided curriculum
- g. it is my first year using this curriculum and I want to (or have been asked to) try it as written
- h. Other, please specify. (or feel free to elaborate on another answer choice)

For all respondents:

27. Before moving on to the last section, is there anything else you would like to share about your use of math curricula?

Part 5: Teaching Mathematics

These next questions are about the context in which you teach math and how you feel about different aspects of your math teaching.

28. Please rate how true the following items are for you when teaching mathematics this year.

Scale from 1-4. 1: Definitely false, 2: Somewhat false, 3: Somewhat true, 4: Definitely true

- a. In my mathematics teaching, I use my own guidelines and procedures
- b. In my situation, I have little say over the mathematics content and skills that are selected for teaching.
- c. My mathematics teaching focuses on those goals and objectives I select myself.
- d. What I teach in during mathematics is determined for the most part by myself.
- e. The mathematics materials I use in my class are chosen for the most part by me.
- f. The mathematics content and skills taught in my class are those I select.

29. How well do you feel you can perform the following when teaching mathematics this year:

Scale from 1-9. 1: Not at all, 3: A bit, but not very well, 5: Somewhat well, 7: Pretty well, 9 Very well)

- a. Provide challenging tasks for very capable students
- b. Enhance students' creativity
- c. Pose good questions
- d. Help students appreciate the value of learning mathematics
- e. Motivate students who show low interest in mathematics
- f. Adopt a variety of teaching strategies
- g. Monitor the level of understanding of an introduced concept
- h. Provide help to a failing student
- i. Adapt teaching to meet a student's needs
- j. Use alternative explanation techniques
- k. Respond to a student's challenging questions
- l. Help students work collaboratively

Appendix B: Interview Questions

Interviews were conducted in-person and audio-recorded for later transcription. To support later transcription, the interviewer also took notes during the interviews, using a packet of the protocol shown below that was formatted into a two-column format: questions in the left column and empty space for notes in the right column.

Questions #4, #8, and #9 (and their associated response tables) were organized into a single-sided worksheet for participants to view and use while answering those questions. Most participants marked the sheet themselves as they talked aloud, but some preferred to provide their responses aloud and have the interviewer write their responses down.

Provided Curriculum:

1. Were you provided with a math curriculum this school year (by your school or district)?
 - a. What math curriculum were you given?
 - i. For how many years has this curriculum been provided to you?
 - ii. Are you required to use it? (Describe requirements/oversight or lack thereof)
 - Would you prefer the school/district have different requirements?
 - b. If “no,” what did you use instead?
2. How would you (*briefly*) describe the overall quality of the provided curriculum?
 - a. What are its strengths? (/aspects you like the best)
 - b. What are its weaknesses? (/aspects you like the least)
 - c. Any other likes or dislikes?

Outside Curricular Materials (general):

3. What are the situations in which you considered using outside materials in this past year?
 - a. for particular content areas?
 - b. for particular types of activities?
 - c. for particular sections of the textbook?
4. What percent of the materials that end up reaching your students in some way¹⁹ ...
(presented as a table for participants to fill out while discussing aloud)

...comes directly from the textbook?	_____ %
...was adapted from the textbook in some way?	_____ %
...was created “from scratch”?	_____ %
...is an outside material you heard about and decided to use?	_____ %
...is an outside material you actively searched for?	_____ %
Total =	100%

5. How do you decide to create new materials “from scratch” versus use or adapt from an existing source? (i.e., what is most influential on your decision?)

¹⁹ From: Taylor, M. W. (2010). *Replacing the “teacher-proof” curriculum with the “curriculum-proof” teacher: Toward a more systematic way for mathematics teachers to interact with their textbooks*. Stanford University.

6. When you search for or hear about outside materials, what format are they usually?
(E.g., full lesson plans, vs. worksheets/activities to include in a full lesson, etc.)
 - a. Are there particular formats that you look for?
 - b. Or particular formats you avoid?
7. Once you have found an outside material, I'd like you to think in general about what you're looking for when you're deciding whether or not to use it:
 - a. For example, do you read the material thoroughly, skim the entire thing quickly, look at specific elements, do some problems, or a dry run?
 - b. Also, what questions do you ask yourself when deciding whether or not to use it?
 - c. Do you typically feel that you have enough information to evaluate an outside material thoroughly?
 - d. When deciding among multiple options, how do you choose? (e.g., develop a shortlist of "maybes" and then narrow down from there)
8. In general, how do these characteristics influence your decision to use an outside material:
(presented as a table for participants to fill out while discussing aloud)

Characteristics of curricular materials:	Not a factor in my decision	A somewhat influential factor	A very influential factor
a) Designed for my grade level			
b) Designed for students who are performing below grade level			
c) Designed for students who are performing above grade level			
d) Recommended by another teacher			
e) Recommended by a math specialist/ expert/ coach			
f) Uses manipulatives			
g) Cost is affordable			
h) Quick to prepare materials (e.g., copy worksheets, manipulatives, etc.)			
i) Quick for me to learn how to use			
j) Appears to be engaging for students (Describe)			
k) Involves group work			
l) Involves individual work			
m) Involves whole class discussion			
n) Other (anything else you look for/avoid?)			

9. What is the most important characteristic when you're evaluating an outside material?
10. So when you come across an outside material, you're looking for _____ and avoiding _____
 - a. Is that right?
11. And once you've decided to use an outside material, do you typically use it as-is or do you typically adapt it?

- a. What is that adaptation like?
- b. How does it compare to adaptations you make during your use of provided materials? (e.g., more adaptations, fewer adaptations, amount of time, satisfaction with final product)

Outside Curricular Materials (specific):

So now let's look at the specific outside materials you've considered using. Which would you like to start with?

First instance:

12. Tell me about the time when you considered using these materials.

Prompts if necessary:

- a. Did you hear about the materials first and then consider using them, or did you look for something specific?
 - i. How did you hear about them? Do you do anything in particular to ensure you're hearing about new materials?
 - ii. Why were you interested in looking for something new? What math topic were you looking for materials for?
 - b. If looking for specific:
 - i. How did you go about finding materials? Where did you start? What method was most useful in this instance?
 - c. Once discovered, what made you think you'd like to use them?
 - d. Are there any downsides or potential downsides to using these materials?
13. Let's look at the provided materials that relate to this instance.
- a. What do you like about these materials?
 - b. What do you not like about these materials?
14. And returning to the outside materials,
- a. are there specific ways in which they improve upon the provided materials?
 - b. what did you have to do to prepare to use them in your classroom?
 - i. (could include making copies, buying manipulatives, seeking additional educative materials, making changes, etc.)
 - c. what changes (if any) did you make before using them in your classroom?
 - i. Are these similar to the changes you might make to a provided material?
15. *If the outside materials were used:*
- a. Would you continue to use these materials in the future? What changes might you make? Does this feel like the ideal way to teach this topic, or do you expect to look for alternatives?
16. *If outside materials were not used:*
- a. Why did you choose not to use them and what did you do instead? What would be the ideal way to teach this topic?

Probing follow-up questions to be used throughout the interview as necessary to clarify meaning:

- What do you mean by _____?
- What about the material tells you that it's _____?
- For you, why is that important?

- What's important for students to understand about [content area]?
 - How do students come to get that understanding? What's the process like?

(Time-permitting) Now let's move on to the second instance of considering an outside material
Second instance: [repeat questions listed above under "First instance"]

Typicality Questions:

17. Is this typical of how you usually come across and evaluate outside curricular materials?
18. Are there times when it's different? How so?
19. Is there anything else about your curricular planning or decision-making that we've missed?

General Math Teaching²⁰:

I would also like to get a sense of how you think about math teaching, and what goes into high quality math instruction

20. If you were asked to observe a teacher's math classroom for one or more lessons, what would you look for to decide whether the mathematics instruction is high quality?

Potential follow-up questions:

- a. Why do you think it is important to use/do _____ in a math classroom?
- b. Is there anything else you would look for? If so, what? Why?

If not discussed already:

21. What are some of the things that the teacher should actually be doing in the classroom for instruction to be of high quality?
22. What would classroom discussion would look and sound like if instruction was of high quality?
23. What type of tasks do you think the teacher should be using for instruction to be of high quality?

²⁰ From: Munter, C. (2014). Developing Visions of High-Quality Mathematics Instruction. *Journal for Research in Mathematics Education*, 45(5), 584–635.

**Appendix C: Codes Used During Data Analysis
(an illustrative but not exhaustive list)**

<i>Categories of Descriptive Codes</i>	
Curricular Material Source	provided material (general) provided material (specific) outside material (general) outside material (specific)
Curricular Material Format	lesson plan activity idea worksheet manipulatives discussion prompt
Types of Math Activities	develop/practice computation skills engage in a math investigation/discovery process engage in rich mathematical discussions
Student Identity	home language race/ethnicity SES identified as gifted identified as requiring special education
Teacher Identity	personal liking of math self-efficacy for teaching math history with math as a teacher history with math as a learner
Teacher Perspectives	views of high-quality math teaching views of how students learn math goal of math teaching
Institutional Contexts	school-level contexts district-level contexts district expectations around use of provided materials institutional support of using outside materials lack of support for using outside materials
Other Descriptives	Pro (strength/positive evaluation) Con (weakness/negative evaluation) CCSS-M
<i>Decision Process Codes and Sub-codes</i>	
Superordinate Codes	Sub-codes
Consider	provide preparatory background provide additional post-instruction review support ELLs support students with low math skills challenge students with high math skill

Discover	<p>through another teacher through a math coach/specialist through a generic online search through a known website</p> <p>passive discovery (come across) active discovery (search)</p>
Evaluate	<p>designed for students at grade level recommended by another teacher recommended by a math coach engaging for students low cost short time to prepare includes group work includes individual work includes whole-class discussion</p> <p>among most influential characteristics among least influential characteristics a characteristic I look for a characteristic I avoid</p>
Prepare/Adapt	<p>extensive preparation minimal preparation adapt to increase mathematical challenge adapt to decrease mathematical challenge adapt to decrease language demand adapt to increase visual appeal adapt to increase partner/group involvement</p>