TEACHERS' DECISIONS ON TASK ENACTMENT AND OPPORTUNITIES FOR STUDENTS TO LEARN

Ok-Kyeong Kim
Western Michigan University
ok-keyon.kim@wmich.edu

Napthalin A. Atanga
Western Michigan University
achubang.a.napthalin@wmich.edu

Drawing on data from teachers using various elementary mathematics curriculum programs, this study highlights prevalent decisions teachers make to enact the task from the written curriculum and the potential of such decisions for student learning. In doing so, we examine teachers' instructional design decisions, especially those that teachers make when they face things that are not specified in the curriculum and when they see the need to fill in a gap in the teacher's guide in order to enact the task in their classrooms. We also examine whether such decisions can actually create opportunities for students to learn.

Keywords: Curriculum, Instructional Activities and Practices, Curriculum Analysis

Teachers make various *design decisions* when they use curriculum to plan and enact a lesson. First, they need to decide whether to use the task in the curriculum and, if so, how to use it. The curriculum usually includes various kinds of information regarding how to enact the task, such as questions to ask; representations, models, and strategies to use; a set of components of the task; and statements to make. Teachers decide whether to use, modify, or omit each of these provided in the curriculum. We call design decisions involved in this process *fidelity decisions*. Second, teachers need to determine a number of things to enact the task after fidelity decisions are made. Such decisions, which we call *enactment decisions*, need to be made especially when modifications are made or when the curriculum does not address things that may occur in a variety of situations during the enactment of the task. Even though we distinguish the two kinds of design decisions, they are closely related: fidelity decisions affect enactment decisions and vice versa. Sometimes one teacher decision can be both a fidelity and enactment decision (e.g., modifying a question suggested in the curriculum to build on previous learning). It is important to investigate teacher design decisions in terms of the two kinds of decisions and the relationship between them.

As a way to explore teacher design decisions, in this study we examine enactment decisions that teachers make along with fidelity decisions, especially when they face things that are not specified in the curriculum and when they see the need to fill in a gap in the teacher's guide in order to enact the task in their classrooms. We also examine whether such design decisions can actually create and increase opportunities for students to learn, given that teachers take specific actions to help students reach the goals they set for the students. Teacher enactment decisions can maximize the impact of the task on student learning and also can limit the impact, even though teachers have goals for student learning.

Theoretical Foundations

Teachers' ways of using curriculum materials are very diverse (Remillard, 2005). All teacher decisions involved in curriculum use, however, require determining whether to use the curriculum, how to use it, and to what extent. Often the term fidelity of implementation is used to help explain and elaborate on curriculum use. Fidelity of implementation has been investigated from different perspectives, such as the philosophy and pedagogy of curriculum materials (Chval, Chávez, Reys, & Tarr, 2009), adaptations that maintain curriculum designers' original intent (Huntley, 2012), content coverage and presentation of content (Tarr, McNaught, & Grouws, 2012), the extent of coverage of curriculum materials (Tarr, Chávez, Reys, & Reys, 2006), and literal lessons versus intended lessons (Brown, Pitvorec, Ditto, & Kelso, 2008). Yet, investigations on specific decisions teachers make in individual lessons (e.g., whether to use particular questions and prompts suggested in the curriculum) have rarely been conducted, nor, in particular, how such fidelity decisions shape the enactment of the lesson.

The National Research Council (NRC, 2001) points out that opportunity to learn (OTL) is "the single important predictor of student achievement" (p. 334). Hiebert and Grouws (2007) explain that OTL depends on both teacher and curriculum materials. They further argue that creating moments in classrooms where students learn goes beyond exposing them to subject matter and learning goals. Stein, Remillard, and Smith (2007) argue that curriculum materials can influence students' learning, as they may contain mathematical tasks with cognitive demand that requires reasoning and problem solving. However, whether the task is used as intended depends on the teacher. Stein, Grover, and Henningsen (1996) find that even with tasks that require high cognitive demand, teacher actions can deprive students of opportunities to reason and think mathematically. Also, teachers may eventually change goals and mathematical points of the task (Sleep, 2012). These arguments may indicate that even though both curriculum materials and teachers are significant in creating opportunities for students to learn, the teacher's role seems even more critical. Many factors that can help create opportunities for the student to learn may be present in curriculum materials, and yet they may also lie fallow if not deliberately pursued by teachers during the enactment of lessons. Potential reasons may be partly because teachers make poor fidelity decisions, and partly because teachers need to decide a number of additional things on their own besides those specified in the written materials and tasks.

Research literature is replete with studies that inform us of modifications teachers make when engaging with mathematical tasks (e.g., Brown, 2009; Brown, Pitvorec, Ditto, & Kelso, 2008; Lloyd, 2008; Remillard & Bryans, 2004). Only a few studies, however, attempted to articulate teacher design decisions; even fewer studies examined the connections among modifications teachers make to the task (fidelity decisions), specific things teachers do to enact the task (enactment decisions), and kinds of learning opportunities students may experience (OTL). This study focuses on enactment decisions along with fidelity decisions and the potential of such decisions for student learning; in order to investigate enactment decisions, it is necessary to find out what fidelity decisions are made. In particular, questions that guide our study are: What enactment decisions do teachers make when they decide to use a task from the curriculum? In what ways do such decisions help create or increase OTL?

Methodology

This study is part of a larger study investigating teacher curriculum use – *Improving Curriculum Use for Better Teaching* (ICUBiT) project. The data analyzed in this study were drawn from this larger study.

Teacher participants and curriculum programs. Data were gathered from teachers in grades 3-5 using five different curriculum programs: (a) *Investigations in Number, Data, and Space* (INV), (b) *Everyday Mathematics* (EM), (c) *Math Trailblazers* (MTB), (d) Scott Foresman–Addition Wesley *Mathematics* (SFAW), and (e) *Math in Focus* (MiF). The first three were NSF-funded programs; the fourth was commercially developed; the fifth was originally from Singapore and has gained popularity in the U.S. over recent years. We used a range of programs because we wanted to investigate teachers' approaches in using curriculum in general, not specific to particular types of curriculum, and what it takes to use curriculum programs effectively, regardless of types of programs. The participant teachers had at least three years of teaching experience and at least two years of using the same curriculum program. We intentionally recruited teachers with such experience because our aim was to investigate teachers' ways of using curriculum materials, not their learning to use curriculum materials, which is typical in novice teachers and those who are beginning to use a new program. This study drew on data from five teachers, one teacher per curriculum.

Data sources. The data we used in this study include classroom observations, teacher interviews (introductory and post-observation), and Curriculum Reading Logs (CRLs). Each teacher completed CRLs for each lesson that was observed: on a copy of the written lesson, the teacher indicated which parts they read as they planned instruction, which parts they planned to use, and which parts that influenced their planning, in yellow, blue, and orange highlighters, respectively. CRLs helped the researchers see plans for instruction and compare written and enacted lessons. Each teacher was observed for three consecutive lessons in each of two rounds. These enacted lessons were videotaped and transcribed. Also, each teacher was asked questions about his/her teaching experience and overall curriculum use at the beginning of the study, and then asked about specific teacher design decisions in the observed lessons after each round of three observations. These interviews were audiotaped and transcribed.

Data analysis. The main part of the data analysis was coding teacher fidelity and enactment decisions to examine the kinds of things teachers did that were not specified in the curriculum and the things that they did differently from the curriculum. We focused on one lesson per teacher, and the content of the observed lessons was primarily number and operations. First, we chunked Written (W) and Enacted (E) tasks using CRLs and videotaped lessons, and created lesson analysis tables that included W- and E-tasks side-by-side. We defined a task as a chunk of activity (including teacher and student activity) aiming at an apparent distinct goal or product. In this way, we examined each lesson in smaller chunks, rather than as a whole. This was because teacher goals, actions, and decisions may vary depending on the task. In each pair of W- and E-tasks, we identified teacher fidelity decisions (task components, questions, statements, representations, strategies, participation structure, time allocation, etc.)—whether each of these was used as recommended in the curriculum, changed, or omitted, or whether any new things were added. Also, we constantly compared the W- and E-tasks to identify enactment decisions by examining what teachers used from the curriculum, what changes they made, and what they did when things were not clearly addressed in the curriculum or when they filled in the W-task in order to enact it. Once each task was analyzed, we compared teacher actions across E-tasks, first within teacher and then between teachers, to develop preliminary codes and refined them as more tasks were analyzed. We did not include tasks that teachers adopted from outside the program they used, because of the focus of the study. Teacher interviews were analyzed to see teacher intention behind their decisions. After examining individual teachers, we searched for patterns in teacher enactment decisions and their potential impact on student learning.

Results

We found prevalent patterns in enactment decisions that the five teachers made. Regardless of the types of programs they used, they exhibited surprisingly similar patterns. W-tasks from EM and SFAW that included minimal directions and guidance regarding how to enact the tasks and what to do left plenty of room for decisions that EM and SFAW teachers had to make. Even though MTB provided the most detailed guidance for teachers among the five programs, the MTB teacher did a number of things to fill in the gap in the W-tasks to enact them in her classroom. First, we describe the kinds of common enactment decisions and then discuss the potential of these decisions for student learning.

Teacher Enactment Decisions

When teachers used W-tasks to design a lesson, certainly there existed some uncertainty in those tasks. It was found that a number of things were not clearly addressed in the W-tasks, which were up to teachers' own decisions depending on their circumstances. Most of these decisions were intentional with particular goals in mind. The teachers clearly intended to help students get at the mathematics that they thought their students needed to learn from each lesson. To accomplish this goal, they attempted various actions that were not specified in the W-tasks: (a) having an extended launch of the task (including preview of the task, examples, detailed directions, etc.); (b) posing questions and prompts that students need to think about in order to do the task; (c) using additional representations or tools to help students understand something related to the task or to do the task; (d) making directions clear and giving specific guidance to help students complete the task; (e) providing modeling, demonstration, and explanation; (f) tailoring the task in a way that fits the classroom situation (or in the way that the teacher desires); (g) adding a new component to the task (e.g., summary or wrap-up discussion at the end of the task); (h) reviewing previous learning in relation to the task and in response to student thinking; and (i) connecting the task to previous/future learning. Table 1 includes examples of these teacher actions from an E-task of the MTB teacher's lesson. Note that having an extended launch requires many other specific decisions that are included in the table. Also note that these decisions are not mutually exclusive and there are some overlaps among them. In fact, when coding teacher decisions, we found one teacher action could involve multiple decisions. For example, ETA 1 in Table 1 not only helped students think about line of symmetry, but also led to review the concept they learned previously so students could use the concept to do the task.

Each of the five teachers tends to have an extended launch, especially for the main tasks of their lessons. For example, the MTB teacher and EM teacher spend 20 minutes and 25 minutes, respectively, for the launch of one main task they enacted. Interestingly, the W-task from MTB offers very specific guidance, whereas the W-task from EM provides minimal guidance with a bulleted list of three main steps and a couple of additional sentences before and after this list. Yet, both teachers spend a significant portion of their E-task helping students start the task. In such an extended launch, the teachers do a range of things, illustrated in the examples in Table 1. They want to provide very specific directions regarding what to do and how to complete the task. The teachers also ask questions and prompts for students to think about prior to working on the task. In this process, if opportunities come up, the teachers review mathematics concepts and ideas students have already learned that will be used in some way to do the task. They also model or demonstrate strategies, some small steps, or particular ways that are useful or efficient. Sometimes they add new components to the task. For example, the EM teacher provides a preview of the task that helps students see the components and expectations of the task and prepare to start. These are many more details than a curriculum could possibly include. In a sense, curriculum designers assume such teacher decisions and provide potentially necessary information and support for lesson enactment. However, certainly ambiguities exist in each curriculum. The more ambiguities, the more teachers' own decisions are needed to sort out such ambiguities and fill in the curriculum.

Table 1: Teacher Enactment Decisions

Decisions	Example teacher actions (ETA)
Pose questions and prompts students need to think about to do the task	1. How do we find lines of symmetry in general? 2. What else might you trace that would help you to keep track of things? 3. We're going to be using large numbers like in the thousands for addition; anyone have an idea on how we can do this?
Use additional representations/tools	4. If I give you something like this [a base-ten chart]. …… You do not need to use this chart. You can use this chart in your own way. You can do something else than what I have just suggested on the board there.
Make directions clear and give specific guidance to do the task	5. Do you think that there is something about that coat … that would help you be even more efficient than covering the whole coat? Is there something that we know about math that would help us be more efficient than covering up the entire coat? …… We're just going to do the one side, so we'd double it. Good, good.
Provide modeling, demonstration, and explanation	6. Ok, so you can fold your large piece of paper and again it's not going to be exact. You can also eyeball it. … What about if you wanted to, you have your neckline here, what could you, what tool could we use to find out where the middle was there? …… Right, you can measure this from here to here and you might find it's 10 inches and take the middle of, yeah! measure it from here to here.
Tailor the task in a way that fits in the classroom situation (or the way that the teacher desires)	7. We have flats, and then we have skinnies in the bottom. What would you use first? …… with all the bits out and count them up. Is that going to be the most efficient? What are we going to use first? …… This inside of the 2D object. Inside, cover the area. …… First you're going to start off with flats. Then what might we use next?
Add new components to the task	8. I would like to hear from just one or two people, something that you learned today that you didn't know.
Review concept previously learned in relation to the task or student responses	9. So, what is this line called? I am sure you have seen it. We have talked a little bit about it this year. 10. Finding the area, one example would be to find the area of the rug. So what is area? 11. How do we find lines of symmetry in general? …… You can fold it in half.
Connecting to previous/future learning	12. We're going to be doing addition and subtraction, or at least addition with these base 10 pieces. … And, you're going to be able to not just understand how to add or subtract, because you have been doing that for a long time. But we are going to get into some larger numbers. 13. Is there something that we know about math that would help us be more efficient than covering up the entire coat? And I am just going to put in your mind, it's one of the techniques that you use for Joe the Goldfish.

Now we will explain these various enactment decisions by using examples from the MTB teacher's lesson in Table 1. In a W-task from MTB, students are asked to find the area of a coat, using base-ten blocks (bits – ones, skinnies – tens, and flats – hundreds). The context given is that students are asked to find out how much material is needed to cover the front of the coat that will be worn at the school play. Students are expected to discuss specific procedures (e.g., tracing the outline of the coat, and covering half of the front and use that to find the area of the whole thing) and practical points (e.g., the coat should be zipped). The W-task also includes a note that some measurement error can occur. Students are expected to measure the area of their coat in groups of two or three. The written lesson containing this task is for two to three estimated class sessions. The guidance for enactment is provided in much detail. The E-task observed ends before students share the areas of the coats they measured and compare resulting 4-digit numbers (areas), which is done on the following day.

Even with the detailed guidance (see TIMS Project University of Illinois at Chicago, 2008, pp. 36-37), as shown in Table 1, the MTB teacher makes various enactment decisions to use the task in her classroom. She makes prompts very specific to help students work on the task in a desired way. It is efficient to measure only half of the coat and double it, and this strategy was mentioned in the W-task. The teacher not only brings up this strategy, but also makes sure students can use this strategy effectively by connecting a strategy students used in a previous task to this new task (ETA 13); posing questions to encourage students to think about the concept that is useful to do the task (ETA 1); reviewing the concept, line of symmetry, and how to find it (ETAs 9 and 11); providing demonstrations of how to find the line of symmetry (ETA 6); and giving specific directions on how to use the symmetry of a coat to do the task, i.e., find half the area of a coat and double it (ETA 4). She even has students consider a particular measure of the neckline (10 cm) and demonstrates what can be done using the outline of a coat on the board. One issue students may have in the task is keeping track of their record. When they place base-ten blocks to measure the area of a coat, the blocks can be easily moved from the correct place, which can make it hard to accomplish the task. In the W-task, it is recommended that students "trace the outlines of the base-ten pieces on the picture of their coats and figure out the area afterwards" (p. 37). The teacher emphasizes the importance of tracing blocks as students place them and discusses ways of tracing them in a very specific manner. Along with efficiency, she prompts students to consider that they should use flats first and then skinnies and bits (ETA 7). She even comments that, rather than tracing each bit individually, students can place and trace a group of bits and record the total number of those bits. She also encourages students to think about whether to place flats first and recommends that students start along the line of symmetry. These very specific directions and guidance are not clearly addressed or directed in the W-task, even though it does show a figure of outlines around the base-ten blocks, with flats used first along the line of symmetry. The teacher also suggests that students can use a base-ten chart to keep track as they trace blocks (ETA 4), and she demonstrates how to use the chart to record their work in progress and mentions that recording tallies (number of flats, skinnies, and bits traced) on the chart is one way to use this tool to complete the task. Finally, she adds a component that is not included in the W-task. She encourages students to reflect on their exploration by asking them to talk about what they learned in the task (ETA 8).

Opportunities Created for Student Learning

From the teachers' perspective, opportunities to learn may be envisioned in different ways. Even though the five teachers made some common enactment decisions, it seemed that these decisions resulted in different opportunities for student learning: nurturing or constraining OTL.

Martinez, M. & Castro Superfine, A (Eds.). (2013). *Proceedings of the 35th annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education.* Chicago, IL: University of Illinois at Chicago.

It is not that a particular teacher always nurtures or constrains OTL, even though there are some patterns in individual teachers. Depending on their focus of the task (they certainly interpret the W-tasks and determine their own goals to achieve by using the tasks) and decisions and actions they make, they create different kinds of OTL and can potentially limit OTL. Likewise, a particular enactment decision (e.g., giving specific directions) does not always nurture or constrain OTL. Depending on how teachers do it, for example, giving specific directions can enable students to focus on the mathematics they learn by removing unnecessary confusion, but it also can limit room for student exploration by eliminating students' struggles that may be important for them to experience. Students are expected to complete the task in an efficient way, and yet formulating procedures for students and equating particular types of problems with particular strategies seem to limit opportunities for students to think and make their decisions and then learn from the results of their decisions. They may experience difficulty or may struggle with their approaches, but this experience makes them learn the importance of certain things, such as keeping track and placing flats first, rather than bits, to measure the area of the coat.

An example of enactment decisions that constrains student learning is from the INV teacher's E-tasks about multiplication and division. This teacher focuses on key words throughout the lessons on multiplication and division by posing questions, giving specific directions, providing explanations, and tailoring the tasks toward finding key words. She tailors the tasks so her students can identify key words to determine which operation is needed, although the same keywords can lead to different operations. She deliberately does this to minimize students' confusion about whether to multiply or divide. However, while giving these specific directions and examples repeatedly, she limits time to discuss the meaning in the story problems (e.g., how to represent the story problems and how to use such representations to make sense of the problem situations and solve them) and the relationship between the two operations. As a result, after two days of using key words, most students were still confused about which operation was needed in which problem situation.

In contrast, the MTB teacher nurtures student learning overall, even though she tries to control and tailor student exploration at times in a way that constrains OTL. She frequently poses questions to invite student thinking and encourage students to consider various concepts and ideas related to the task. Such questions could be funneling and yet she manages to keep them open so that students can remind themselves of previous learning, connect that to the new task they are about to start, and think about approaches to the task. She deliberately suggests the base-ten chart and demonstrates how it can be used, and yet lets students decide whether to use it and how to use it. When trying to give clear directions, the teacher uses student thinking and has students come up with ideas along the way, rather than simply directing them to follow a set of procedures. Also, she adds a component at the end of the E-task that helps students reflect on the overall process. The lesson containing the W-task requires more than one session. The teacher's guide does not indicate where the task could potentially be suspended, let alone how to do so. The teacher decides to have students talk about what they learned and reflect back on their work on the task through this added component. Overall, she guides students in a very specific and organized way to engage students with the mathematics of the task.

Significance

It is surprising that there are still a number of decisions teachers have to make, even enacting W-tasks that include detailed guidance for the enactment (e.g., MTB). These decisions influence learning opportunities for student to experience. The results of this study can be used in teacher preparation and professional development to help teachers make such design decisions in a way that can nurture student learning. The results can also be used to provide support for teachers to help them make better decisions. For example, the lessons on multiplication and division in INV can address how to guide students about key words and operations in a clearer way than the current edition (e.g., questions to ask, prompts to give, and directions for the task).

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