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THE ROLE OF TEACHER AND CURRICULUM IN INTERVENTIONS IN DAILY LESSONS

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ABSTRACT: The demand of interventions in daily lessons is high in the classroom, and curriculum programs make an effort to include resources for such interventions. Yet, there is no clear theoretical and practical guidance on daily interventions for both teacher and curriculum. This study examines interventions that are offered in written lessons from a range of elementary mathematics curriculum programs and those that teachers actually incorporate into instruction, aiming at understanding the nature of interventions embedded in daily lessons and the role of teacher and curriculum in classroom interventions. The results of the study highlight the importance of intervention resources in the curriculum and teacher role in recognizing the affordances of resources to provide appropriate interventions toward the mathematical point of the lesson.

Key words: intervention, curriculum, teacher knowledge, elementary

INTRODUCTION

This study focuses on interventions *within* daily lessons that are designed to support students when they have difficulty understanding the instructional material or completing the assigned task. Teacher reactions to student difficulties can be based on planned or on-site decisions. In either case, these interventions provide short, prompt support situated within regular ongoing lessons along with the curriculum being used, as opposed to a long-term program segregated from daily lessons. The demand of interventions in daily lessons is high in the classroom, and curriculum programs make an effort to include resources for such interventions. Yet, there is no clear theoretical and practical guidance on daily interventions for both teacher and curriculum. This study examines interventions that are offered in a range of curriculum programs in the US and those that teachers incorporate into instruction, in order to understand the nature of interventions embedded in daily lessons and the role of teacher and curriculum in these classroom interventions. Specific research questions are:

1. What kinds of interventions are provided in the written lessons from a range of elementary mathematics curriculum programs?
2. Which interventions do teachers use among those available in the written lessons and in what ways?
3. What do teachers do when no interventions regarding observed student difficulty are available in the written lessons?

THEORETICAL PERSPECTIVES

Often, interventions are interpreted as special courses of instruction, usually with long duration, to promote important learning goals that typical classroom practice has had difficulty in supporting (Stylianides & Stylianides, 2013). These interventions are usually designed and tested through teaching experiments (e.g., Blanton, Stephens, Knuth, Gardiner, Isler, & Kim, 2015; Thomas & Harkness, 2013), and such interventions utilize existing research and innovative approaches to redesign instruction for a particular topic and/or a specific pedagogical aim. In contrast, while steering daily instruction, teachers provide interventions moment by moment in order to accomplish lesson goals when they observe students struggling in understanding and using a particular concept to complete an assigned task or to solve a problem. Alibali, Nathan, Church, Wolfgram, Kim, and Knuth (2013) call this latter type of intervention a *micro-intervention* in that it occurs "as a lesson unfolds" at the micro level. Timely interventions are critical in enacting lessons productively, and our field needs to understand the nature of these interventions embedded in daily lessons.

There has been little research examining the nature of micro-interventions. Although they examined micro-interventions, Alibali et al.'s (2013) focus was mainly on non-verbal teacher actions in trouble spots, such as

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gestures. Other studies investigated some general approaches to interventions, such as student interactions and levels of mathematical content (e.g., Dekker & Elshout-Mohr, 2004). Nevertheless, previous research on interventions has not examined how teachers use curricular resources to intervene when students have difficulty with the main mathematical idea of the lesson.

Even though it is difficult to plan daily interventions since any issue can come up during instruction, there are foreseeable student struggles on the main mathematical idea of the lesson. Many curriculum programs provide anticipated difficulties students may have around the mathematical point of the lesson and suggestions for teacher actions in such occurrences. In implementing written lessons, teachers evaluate curricular resources as well as student thinking to determine appropriate teaching actions. Therefore, micro-interventions impose challenges, on both teacher and curriculum, of predicting student struggles and addressing issues productively toward learning goals. Emerging questions are: How do curriculum programs support teachers to prepare for dealing with students' difficulties in daily lessons? How do teachers use such resources in the curriculum to cope with the moments in which students need extra support? This study investigates the nature of micro-interventions around the mathematical point of the lesson and the relationship between the interventions provided in written lessons and those in enacted lessons.

METHODS

Data Sources

This study draws on data from a larger study on teachers' use of curriculum materials to design instruction in grades 3-5 in the US. For curriculum analysis, 15 lessons (five per grade) were randomly selected from each of five elementary mathematics curriculum programs, ranging from reform-oriented to commercially developed: (1) *Investigations in Number, Data, and Space* (INV), (2) *Everyday Mathematics* (EM), (3) *Math Trailblazers* (MTB), (4) *Math in Focus: Singapore Math* (MiF), and (5) Scott Foresman–Addison Wesley *Mathematics* (SFAW). Twenty-five teachers (five per program) were observed in two rounds of three consecutive lessons and interviewed after each round of observations. All the observed lessons were videotaped and transcribed; the interviews were also transcribed.

This study uses all the written lessons selected to see the patterns in interventions from each program. This study also uses enacted lessons and interviews from all five teachers implementing INV and one teacher per program for the other four programs who was representative of the teachers using the same program. Data from all INV teachers are used because INV is unique in providing interventions in terms of their frequency, extensiveness, and emphasis. For example, each INV lesson includes a section of "INTERVENTION" after the main student activity/task, providing anticipated student difficulty and suggested teaching actions. The other four programs include a section of intervention in varying degrees. Besides those in the designated area, all five programs occasionally include intervention suggestions along with anticipated student struggle in the lesson guidance. All the observed lessons and interviews of the nine selected teachers were used for analysis. The written lessons used by the nine teachers were also collected for analysis of interventions in the curriculum and for comparison of written and enacted lessons.

Data Analysis

First, I analyzed the nature of interventions in the written lessons per program: their frequency, format and location, emphasis (procedural or conceptual), relationship to the mathematical point of the lesson, and extensiveness of guidance. Then, I specifically focused on the written lessons that the nine teachers enacted in order to examine written interventions and anticipate what difficulties students might have and what teachers might do in the enacted lessons.

When analyzing the enacted lessons, first I identified trouble spots in each lesson where interventions are needed, by using the criteria Alibali et al. (2013) articulated: student-initiated questions, incorrect responses and statements, and lack of certainty. Then, I analyzed how teachers reacted in these core trouble spots in each lesson and compared and contrasted each teacher's interventions during instruction with those provided in the written lessons in order to find a pattern within each teacher. When there was no specific intervention provided in the written lesson, I examined how the teachers utilized resources provided in the instructional guidance (e.g., directions, representations, and mathematical explanations) of the written lessons while helping students with difficulty. In order to understand teacher intentions behind their specific intervention, I analyzed teacher interview responses to questions on specific teacher actions during the observed lessons. Finally, I compared and contrasted the patterns in the nine teachers' interventions along with the written lessons they enacted.

RESULTS

Overall, interventions in the written lessons were limited in terms of the specificity and comprehensiveness, and many of the micro-interventions in the enacted lessons were not productive, especially when important resources

provided in the written lessons were not used. The results of the study are briefly presented in three parts: (1) overall interventions in the written lessons in the five curriculum programs, (2) teacher interventions in relation to those provided in the written lessons, and (3) teacher interventions when there were no specific interventions provided in the written lessons.

Interventions in the Written Lessons

Interventions provided in the written lessons of the five programs vary greatly. Whereas EM seldom provides interventions, MiF and MTB occasionally do in designated sections called, respectively, "Common Errors" and "For Struggling Learners," and "Meeting Individual Needs." INV and SFAW include interventions along with "on-going assessment" on a regular basis. MiF and SFAW tend to have interventions on procedural errors. For example, MiF includes the following guidance in one of the written lessons examined: "Students may not always write their answers in simplest form. Remind students to check that the numerator and denominator in their answer have a common factor other than 1." INV provides the most extensive guidance for intervention, including specific actions often along with questions to ask and materials to use (see Figure 1). INV interventions address student difficulty with the mathematical point of the lesson, providing conceptual support for those who need assistance in the content of the lesson.

Although INV lessons usually provide useful interventions, sometimes it is not clear when to do such interventions, or the curriculum explains only what students may benefit from without indicating a specific struggle or any other specific instructional suggestion. For example, in a lesson on using two arrays to make a rectangle, the only intervention provided is: "Some students may benefit from working with you in a small group while others work in pairs. Students in the group take turns choosing a large array for the rest of the group to match with two small arrays." Also, some interventions in INV have limitations in addressing student struggles sufficiently because they simply suggest teachers use smaller numbers in the problems.

Interventions in the Enacted Lessons

All the enacted lessons exhibited student difficulty in relation to the mathematical point of the lesson at various moments. Students expressed their difficulty or confusion in varying degrees. In some classrooms, students' difficulty was related only to procedures because that was the focus of the lesson; in others, students expressed their confusion based on the lack of conceptual understanding. Surprisingly, the teachers who were analyzed rarely used interventions provided in the written lessons. They created their own interventions regarding the mathematical points of the lesson. In some cases, teacher actions apart from curricular guidance caused student difficulty. Although INV provides the most extensive and conceptually based interventions among the five programs analyzed, the teachers implementing INV did not utilize most of the interventions that could have been very effective in the trouble spots that they faced. The same trouble spots recurred since they were not handled properly. For example, one teacher emphasized key words in solving and creating multiplication and division story problems, and her students had tremendous difficulty creating their own word problems. The intervention suggestions provided in the written lessons are:

> Help students talk through the elements of a multiplication situation (two known factors and an unknown product and a division situation (product and one known factor). Write multiplication and division equations with small numbers and ask students to model the action of each with cubes. (TERC, 2008, p. 127)

This intervention guidance is further detailed with the specific script shown below, to use during intervention.

> Look at this equation, 3×4=__ (or 12÷4=__). Can you show me with cubes what this problem would look like? Can you think of a situation to write about in which you might have 3 groups of 4 things (or 12 things divided into groups of 4 or 4 groups)? (TERC, 2008, p. 128)

As seen above, the written lesson predicted that students would have difficulty distinguishing multiplication and division situations and creating story problems on their own, and provided detailed guidance to support such students. The intervention highlights the meaning of multiplication and division with a pair of related equations (i.e., 3×4=__ and 12÷4=__). The written lessons also include the following guidance, using the meaning of equal groups:

> Listen for student understanding of the difference between multiplication and division. For example, do the problems students make for the expression 18÷3 begin with the quantity 18 and divide it into 3 equal groups or groups of 3? Do the problems for 6×3 involve 6 groups of 3 or 3 groups 6? (TERC, 2008, p. 126)

The written lessons consistently emphasized the equal groups meaning of the two operations in order to highlight their similarities and differences and guided teachers to do so. Not using any of the extensive specific interventions, however, the teacher repeatedly reminded students of key words they generated. In her interventions the teacher constantly stated, for example, "If it says 'in each,' it's gonna be a division problem." She also asked questions, such as, "Now remind me, what are our multiplication key words? If it's a multiplication story problem, it's gonna have what key words in it?" As a result, she lost an opportunity to

highlight the characteristics of multiplication and division in relation to each other, and students continued to have difficulty creating their own multiplication and division story problems.

Teacher Actions When Specific Written Interventions Not Available

When there were no interventions provided in the written lessons or, if any, only procedural ones, teachers had difficulty providing appropriate interventions. Some teachers inaccurately assessed what students had difficulty with or what might have caused the difficulty. It seemed that some teachers did not to know how to help students overcome their constant difficulty understanding and using the main ideas of the lesson. In such cases, they usually tried to tell students facts and information students need to know or repeated the same explanation they had already provided. Even when they tried to assist students with conceptual meaning, they did not go beyond the surface level and stopped pursuing a further intervention.

Although at times no specific interventions were provided in the written lessons, some lessons included critical curricular resources, such as representations and mathematical explanations based on the meaning, which could be used effectively during interventions. I observed that teachers did not use such critical resources provided in the curriculum when tried to help students understand the mathematical ideas of the lesson. For example, the teacher who enacted lessons from MiF did not use a bar model representing addition and subtraction with fractions (see Figure 1). The written lessons introduced two methods for subtracting a fraction from a whole number or a mixed number:

Method 1: $3 - \frac{4}{9} = 2\frac{9}{9} - \frac{4}{9} = 2\frac{5}{9}$

Method 2: $3 - \frac{4}{9} = \frac{27}{9} - \frac{4}{9} = \frac{23}{9} = 2\frac{5}{9}$

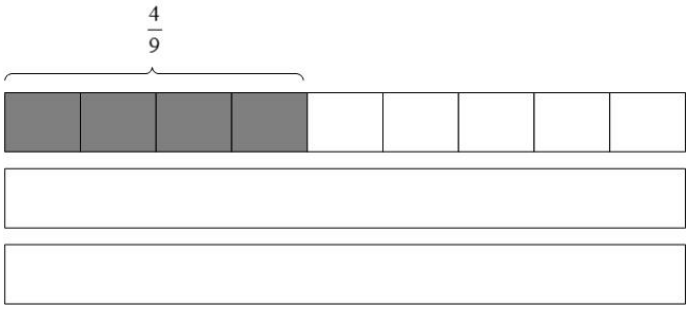

Figure 1. Bar Model Used in MiF to Represent 3 – 4/9

Although students renamed whole numbers as mixed fractions and improper fractions (e.g., $3 = 2\frac{9}{9} = 1\frac{18}{9} = \frac{27}{9}$) in previous lessons, they had a lot of difficulty making sense of the two methods introduced by the teacher and how the two are related. In MiF there were no specific interventions regarding this difficulty other than one sentence in the guidance for the lessons: "Note: Reading the number sentences aloud may help students understand why only the numerators of the fractions are subtracted" (Kheong, Sharpe, Soon, Ramakrishnan, Wah, & Choo, 2010, p. 253). This particular intervention emphasizes the meaning of fraction and fractional units, such as how many ninths are there as a result of subtraction. However, it does not help students understand why 3 needs to be renamed as 2 and 9/9, or 27/9, why both methods work, and how they are related.

As shown in Figure 3, the written lesson uses a bar model to represent 3 – 4/9 visually and conceptually—what it means to subtract 4/9 from 3 and what is left as a result of the operation. Without using the bar model, however, the teacher verbally explained renaming of 3 in different ways (e.g., 2 and 9/9, and 27/9) in order to subtract 4/9. Explaining renaming without the model kept the concept on an abstract level and students continued to have difficulty understanding similar solutions to other problems in the three observed lessons. Without the representation, her explanations did not help students see the rationale for the procedures, and many of the students chose just one of the two methods to solve other problems and were not able to relate the two methods presented in the written lessons. Even when students mentioned using the model ("I can draw a picture on the board"), the teacher said, "No, that's okay. If somebody needs a picture, we will add that. I don't want to confuse anybody." The teacher strongly believed that the model would confuse students rather than helping them see why the procedure works and explained the renaming repeatedly.

DISCUSSION

This study highlights the importance of intervention resources in the curriculum and teacher role of recognizing the mathematical point of the lesson and the affordances of curricular resources to use intervention resources productively and to create an appropriate one when not available in the curriculum. The latter is a critical component of teacher *pedagogical design capacity*, which Brown (2009) refers to as a teacher's ability to

perceive affordances of the curriculum, make proper decisions, and follow through on plans. This study has implications for teacher education and curriculum design regarding teachers' instructional decisions, although further studies on micro-interventions are needed for theoretical and practical elaborations.

It seems that two kinds of teacher knowledge were particularly critical in the interventions in the enacted lessons: teachers' knowledge of student need (what students have difficulty with and where the difficulty comes from) and curricular knowledge (Ball, Thames, & Phelps, 2008; Choppin, 2011). The teachers recognized student difficulty, but many of them failed to accurately assess the origin of the difficulty and determine what could be done to resolve the problem. Choppin (2011) elaborated teacher knowledge of resources that facilitate student thinking, suggesting that teachers need to recognize the affordances of resources to help students learn the content. It seems that most of the teachers analyzed in this study failed to recognize the affordances of the resources included in the curriculum that they were using.

This study also revealed inconsistences and limitations of intervention resources available in the written lessons. Curriculum developers need to examine the way they provide intervention resources, because crafting appropriate, timely interventions is a real instructional challenge for teachers as they are to make abundant decisions during instruction. Further research can guide the direction for providing proper resources to teachers.

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