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LEARNING TO TEACH WITH MATHEMATICS TEXTBOOKS: HOW PRESERVICE TEACHERS INTERPRET AND USE CURRICULUM MATERIALS

ABSTRACT. This study investigates how four prospective teachers interpret and use textbooks while learning to teach mathematics during university coursework and practicum teaching. Results indicate that prospective teachers had varied approaches to using textbooks ranging from adherence, elaboration, and creation. Factors influencing how they engaged with texts include their practicum classroom setting, access to resources, and their understanding of mathematics. Preservice teachers' attempts to modify textbook lessons raised pedagogical, curricular, and mathematical questions for them that were not easily answered by reference to the textbooks or teacher's guides. Findings indicate that the practicum can, however, challenge preservice teachers to be creative and flexible users of curriculum materials.

KEY WORDS: curriculum materials, elementary teacher education, mathematics education, preservice elementary teachers, textbooks

1. INTRODUCTION

Textbooks are an important part of classroom life in elementary and secondary schools. They provide a framework for thinking about what will be taught, to whom, when, and how. The intended and enacted curriculum in many classrooms and schools is often defined by grade-specific texts, and teachers, as well as students, spend a great deal of their preparation, class, and homework time working with textbook materials (Apple, 1992; Ben-Peretz, 1990; Goodlad, 1984; Schmidt et al., 1997). In mathematics classrooms, textbooks are an intricate part of what is involved in doing school mathematics; they provide frameworks for what is taught, how it might be taught, and the sequence for how it could be taught. This is true in many parts of the world but is especially so in North American classrooms where this study took place.

In spite of the prominent role that textbooks play in schools, and in mathematics classrooms in particular, little attention has been given to the role curriculum materials might play in teacher preparation and teacher development. Some research on curriculum materials has tended to focus on describing the content of texts (Schmidt et al., 1997) or how texts can be used to promote instructional change (Rickard, 1996). On the other hand,

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how curriculum materials might be used to support curricular innovation and teacher learning has become a topic of considerable debate (Ball and Cohen, 1996; Remillard, 2000; Apple, 1992; Ma, 1999).

Apple (1992) for example, argues that texts provide opportunities for teachers to engage in a critical analysis of the economic, political, and social realities outside and within the classroom that help teachers construct and re-construct curriculum materials. Advocates of this position argue that the critical analysis of texts place teachers in a position of professional autonomy. Through an awareness of the social and political contexts of how and what knowledge is represented in texts, teachers could be freed from the "tyranny" of the text and more able to explore the curriculum potential of texts in selecting, adapting and developing material to suit their needs (Ben-Peretz, 1990). Others such as Ball and Cohen (1996) and Remillard (2000) suggest that curriculum materials can contribute to teacher learning particularly when texts are designed with that purpose in mind.

This research extends the debate of how and why teachers should engage in an analysis of curricular materials by including the perspective and actions of preservice teachers. How do preservice teachers interpret and use textbooks? To what extent can they engage in an analysis of curriculum materials? Without extensive teaching experience, preservice teachers have yet to develop knowledge of students, teaching, and learning they can draw upon to study curriculum intensively and meaningfully. In addition, a focus on curriculum analysis from the perspective of curricular autonomy can give the impression to beginning teachers that good teaching requires the development and creation of lessons that are textbook free (Ball and Feiman-Nemser, 1988). This, as Ball and Cohen (1996) note, does not utilize the potential power of textbooks as curricular resources for teacher learning. Our study provides a unique perspective and examines how elementary preservice teachers interpret, use, and possibly learn from curriculum materials in the context of a teacher education program.

1.1. *Learning with and from curriculum materials*

As noted earlier studies of curricular materials have largely focused on the texts' content and implementation. There is however increased interest in studying the role textbooks play or might play in promoting teacher learning. In a recent study, Remillard (2000) found that teacher learning was prompted in experienced teachers' use of innovative curriculum materials. In her study Remillard reports that deciding what tasks to ask students, how to interpret student thinking, and how to design tasks based on what

was presented in the curriculum provided more opportunities for teacher learning than when teachers follow the text verbatim or use more standard and familiar routine approaches.

Although the teachers in Remillard's study used innovative curriculum materials it was not the materials themselves but teachers' attempts to use, adapt and understand their students' work on textbook tasks that prompted them to rethink or change aspects of their practice. Pedagogical change of this type and that is envisioned by reform documents (e.g. National Council of Teachers of Mathematics (NCTM), 2000) require substantive teacher learning and teacher engagement with the mathematics that will be taught. Remillard's research points to the importance of considering curriculum materials as provoking teacher learning rather than as objects guiding teacher implementation.

An interactive relationship between teachers and texts has implications for teacher education and the support needed in order for teachers to learn to use texts to construct curriculum-based learning opportunities for their students. However, efforts to help teacher education students become critical users of texts rather than passive implementers may result in preservice teachers choosing to distance themselves from using textbooks. This was the case for teacher education students in a study by Ball and Feiman-Nemser (1988) where preservice teachers developed the impression from their on-campus course work that "following textbooks and teachers' guides was not 'professional' teaching" (p. 412). These preservice teachers considered their own ideas and views about subject matter and pedagogy to be a better resource for planning what and how to teach than were the textbooks. Ball and Feiman-Nemser questioned the decision to abandon the text particularly when preservice teachers may neither fully understand the content they are attempting to teach nor how to think pedagogically about that content.

Following Ball and Feiman-Nemser, we wondered how teacher education can help preservice teachers learn from teacher's guides and textbooks in ways that support their professional learning toward "developing their own units of study, units that are responsible to subject matter goals and responsive to students" (Ball and Feiman-Nemser, 1988, p. 421) and not just a simple rejection of texts. Our study begins with preservice teachers in a mathematics education curriculum and instruction course. In this course, the preservice teachers were given opportunities to analyze and think critically about mathematics textbooks, problem solving resources, and general curriculum materials. Our study then moves with the teacher education students to the practicum setting, and it is here that we learn more about how beginning teachers draw upon and use textbooks for teaching and as resources for learning how to teach.

2. Research context and method

In order to examine how preservice teachers use and consider using curriculum materials in their teaching, we interviewed, observed, and analyzed the work of four elementary school preservice teachers who were enrolled in a mathematics education curriculum and instruction course. Our analysis focused on the beliefs, knowledge, and actions related to curriculum materials in both the course and practicum settings. Our intent was to describe how the prospective teachers interacted with texts as they were learning to teach mathematics and to possibly explain their actions through exploring various influences and contexts that may have enhanced or constrained their curricular decision-making.

2.1. *Participants and settings*

2.1.1. *Participants*

Four prospective teachers enrolled in a 12-month post-baccalaureate elementary teacher education program at a large Canadian university volunteered to participate in this study. They were members of a group of 33 students attending a required curriculum and instruction in mathematics course taught by the researchers. The four prospective teachers had very different biographies with varied reasons for wanting to become teachers. Elaine (all names are pseudonyms), had just completed her degree in International Relations and had been tutoring English as a Second Language on a part time basis. It was her experience as a tutor and working with people that led Elaine to the teacher education program.

Laurie had majored in Art History and had worked in a day care for 3 years. Laurie's desire to become a teacher was motivated by her work with children as well as the security and financial benefits of the teaching profession. Tara is a mother of three and had recently completed a degree in History and English. The creativity of children and the freshness of their ideas attracted Tara to a teaching career. Matt obtained his degree in Physical Education 10 years ago and had been working in the areas of construction and tree planting since that time to support his international travels. To share his adventures and experiences with others was a large part of Matt's desire to become a teacher.

2.1.2. *The teacher education program setting*

Participants were enrolled in a 12-month post-baccalaureate teacher education program that requires students to take two terms of 10-weeks followed by a 13-week practicum and a 6-week summer session. During the two 10-week terms preservice teachers are required to take both general and

subject specific pedagogical-content courses. The mathematics methods course offered before the 13-week practicum emphasized teaching mathematics through problem solving (Lester, 2003) and engaged preservice teachers in doing mathematics, interpreting children's mathematical problem solving, and planning problem-based lessons.

As part of the course students were required to complete two assignments related to curriculum analysis. One assignment asked preservice teachers to develop a collection of 10 problems. For each problem collected they were asked to solve it and provide a written analysis of the problem, which included consideration of the mathematical content, grade-level appropriateness, and possible problem adaptations and extensions. This assignment was completed about two-thirds of the way through the course.

A second assignment involved preservice teachers in an analysis of a mathematics textbook recommended in the provincial curriculum guidebook or the textbook used in their assigned teaching practicum classroom. This assignment asked preservice teachers to provide a general analysis of a textbook in terms of the implicit and explicit learning theories and teaching methods endorsed, how the content was introduced, and the various features of the book. This was to be followed by a more in-depth analysis of a particular unit in the text from both a mathematical and pedagogical perspective. To provoke further discussion and debate about the design of textbooks a guest speaker to the class provided students with insight into the political and economic issues related to producing textbooks. The analysis and adaptation of a collection of math problems and the analysis of a mathematics textbook were completed toward the latter part of the course.

For the extended 13-week practicum, the prospective teachers in our study were assigned different schools and sponsor teachers. Elaine, for example, was assigned a Grade 4 class in a suburban school. She had 25 students in her class, eight of whom were learning English as a second language. She considered her class to be "very low" in ability and to have discipline problems. Laurie's class was a "quiet" Grade 5/6 split. Laurie also had a few students who did not have English as their first language. Tara was assigned to a school in a working class neighborhood. Her children were in a split class of Grade 3's and 4's, described by Tara as a "low-functioning" group with a great deal of behavioral problems. Matt was assigned a Grade 7 classroom in a suburban area. He had 27 students that he described as "a lively bunch" with "quite a range in abilities".

2.2. *Data collection and analysis*

We used copies of the participant's course work, audio-taped interviews, and classroom observations to gather information related to their

understandings and use of curriculum materials. Photocopies of coursework materials were collected, and included: (1) a written math autobiography; (2) an analysis and adaptation of a collection of math problems; and (3) an analysis of a mathematics textbook. These included instructor comments and feedback.

Participants were interviewed after their coursework and during the beginning stages of their extended practicum. Semi-structured interviews with guiding questions to initiate discussion were used and the interviews were usually one to two hours in length. The interviews were conducted in a way that resembled informal conversations with care taken to establish an atmosphere of mutual trust between the researchers and the participants. In these initial interviews participants were asked questions that elicited their views and experiences about mathematics and the teaching and learning of it. Participants at this time were also asked which curriculum materials they planned to use and the role they expected these materials might play in their teaching and learning to teach.

We observed and interviewed each participant once or twice during their practicum teaching. Our classroom observations included attending to the ways in which participants used the textbook in their teaching and how they engaged students with the curriculum materials. Each classroom observation was often preceded by and always followed by a discussion-based interview with the preservice teacher. These interviews, usually 60–90 min in length, focused on learning more about how the preservice teachers planned for instruction and how they used curriculum materials in their planning. The interviews used excerpts from previous interviews with the preservice teachers by "replaying" participant responses and asking them to comment on their previous ideas. Participants were also asked to describe their current teaching responsibilities, how they prepared for the mathematics lessons taught, the role of textbooks in their teaching, and their concerns about teaching in the practicum.

Analysis of the data first involved the development of interpretive cases (Stake, 1995) for each preservice teacher. In developing each case we coded our observations and transcribed interviews around the preservice teachers' ideas about mathematics, learning, and teaching, and their use of textbook and curriculum resources while teaching. We used descriptive data to characterize the preservice teachers' thoughts about textbook use and mathematics teaching and then used these data to help us understand more about why they used curriculum materials in the ways they did. The analysis of the course assignments involved coding the types of problems selected (e.g. translation, multiple entry points, cross curricular, performance-based problems), how they were adapted, and how the preservice teachers planned to use them in their teaching.

This coding occurred across all problems collected for each and all four participants.

The written case of each preservice teacher thus included analysis of the participant's mathematical and pedagogical beliefs and their use of curriculum materials. Each participant was asked to read and respond to his/her written case. This form of member checking provided valuable feedback on our observations and interpretations and helped us construct a more accurate portrayal of the participants' experiences by including their suggested revisions. After developing each case, we engaged in a cross-case analysis where we examined the cases for similarities and differences. Our analysis at this stage focused on the preservice teachers' perceptions about curriculum materials, how they used curriculum materials in completing course assignments, how they planned to use such materials in their teaching, and how they did use them in their practice teaching.

3. Research results

3.1. *Analyzing curriculum materials during coursework*

We found that the preservice teachers in this study were able to engage in an analysis of curriculum materials during their course work. They were, as Ben-Peretz (1990) suggests, able to select, adapt, and/or develop curriculum materials for their potential students. What we found interesting, however, were the differences across these cases in terms of: (1) the types of problems selected; (2) how problems were adapted; (3) whether or not problems were developed; and (4) how the participants considered using textbooks in their future teaching. Our presentation of the results for this section focuses on these four themes.

3.1.1. *Selecting problems*

Each preservice teacher selected 10 problems from a range of resources including current and older or out-of-date textbooks as well as problem solving and mathematical puzzle books. The four preservice teachers selected problems that were situated in a real-world context. In fact, all of the 40 problems collected by the four preservice teachers were situated in contexts that preservice teachers thought would be meaningful to students. However, not all selected problems could be categorized as "rich learning tasks" (Flewelling and Higginson, 2000) – ones that address many learning outcomes, are cross-curricular, use a broad range of skills, encourage the use of imagination, or emphasize problem solving.

Of the four preservice teachers, Matt, selected problems that Stein et al. (2000) would classify as tasks that emphasize procedures without

TABLE I
Number of rich and procedural tasks selected by preservice teachers

	Procedural learning tasks	Rich learning tasks
Elaine	5	5
Laurie	3	7
Matt	10	0
Tara	5	5

connections. Table I reports the number and type of problem selected by each of the participants that could be classified as rich or procedural learning tasks. This classification was informed by both Flewelling and Higginson's work and Stein and colleagues' classification of mathematical tasks and is only a partial classification. That is, the frameworks we drew on contain a much more elaborated categorization of tasks than we use here, but for the purposes of this study we only use a simplified categorization to quickly show differences in the preservice teachers' collections of mathematical tasks.

Matt's tasks typically focused on procedures, required a single answer, and focused on the use of relatively few skills. An example of one of Matt's problems, to be given to Grade 7 students, highlights these features:

> Chuck bought a new guitar for $49.95, a case for $12.98, a set of strings for $2.49, and two packages of guitar picks for $.49 each. If Chuck uses the $23 he made from the sale of his old guitar as a down payment, how much will he still owe? (*Matt, collection of problems assignment*)

In this case the problem is situated in a real-life context and requires the use of procedures that are implied in the problem to determine the answer. The focus of the problem is to obtain a correct answer with limited opportunities for students to connect, explore, or extend the meaning of the procedures used. All 10 of Matt's problems were of this type.

Samples of more rich learning tasks were found in the collection of problems submitted by Elaine, Laurie, and Tara. These preservice teachers included tasks that focused on problem solving, the development of mathematical concepts, the use of the imagination, and the use of a range of skills. Laurie, for example, included the following problem in her collection:

> Sarah and Carla want to buy 15 cans of fruit that cost $0.62 each. They aren't sure they have enough money, and neither of them has a calculator. This is how each figures out how much the fruit costs:

Sarah	Carla
$10 \times 62 = 620$	Each can costs a little bit more than \$0.60
Half as much as that is 310	We need 15 cans
$620 + 310 = 930$	$15 \times 60 = 900$
The fruit costs \$9.30	So the fruit costs a little more than \$9.00

(Laurie collection of problems assignment)

This problem asks students to examine the appropriateness and reasonableness of various ways of solving the problem. Laurie stated that she would use this problem to focus students on analyzing problem solving approaches and the use of metacognition. "This problem," Laurie stated, "could be used to introduce a discussion on 'thinking about our thinking' during problem solving and to stimulate students to brainstorm about when they need to be able to make calculations in their head (without a calculator)".

3.1.2. *Adapting problems*

The four preservice teachers in this study provided evidence that they had considered how the problems could be adapted. They sought to make problems more interesting for students by using familiar names for characters in the problem setting or by changing the context of the problem to make it more relevant to students' interests. However, the ways in which preservice teachers changed the context ranged from superficial changes to more deeply connected changes. Matt, for example, made more superficial extensions to problems than other preservice teachers. For instance, in a problem that asked students to determine the probability of not selecting a 3 by randomly choosing a card from a set of 6 playing cards marked 1 through 6 he suggested using the entire deck of 52 cards to make it more realistic for students.

Although not as often as their attempts to adapt the context, only Tara and Laurie adapted or extended the mathematical content of the problem. Tara for example offered an extension to the following problem: Determine how many peanuts an elephant had eaten on the first day if it ate a total of 100 peanuts in four days, each day eating 8 more peanuts than the day before. Her extension involved the elephant eating a total of 225 peanuts over 4 days each day eating twice as much as the previous day. This extension changed the problem from one involving arithmetic summation to geometric summation. It is interesting to note that the changes

to mathematical content provided by these preservice teachers focused on increasing the problems' complexity. None of the participants discussed how the problems could be adapted to make them accessible to students of varying abilities.

In considering how they would present their problems and adaptations two of the four preservice teachers shared sample questions that they hoped could be answered by examining students' work. For example, Laurie suggested that one of her problems would help her learn more about her students and how they approach problem solving. She asked: "Do they automatically go to pencil and paper? Do they try different ways? How well do the students work with others? Is there an acceptance of different methods or is there one 'right way'?" Thus, in adapting problems participants tended to focus on adapting the problem context in order to connect the problem to students' lives, while few attempts were made to adapt the mathematical content, and fewer still focused on adaptations in order to explore students' thinking.

3.1.3. *Developing problems*

Of the four preservice teachers, only Tara and Laurie included their own developed mathematical problems in their assignment collection. Tara created three of the 10 problems submitted.

> I am taking my family to McDonald's for dinner tomorrow night. There will be four people, my mom and dad, me and my little sister who is only four. I want to treat them with the birthday money I got from my Grandma. How much money will I need to take with me? (*Tara, collection of problems assignment*)

In discussing this problem, Tara states that "in this problem the justification for the answer is more important than the answer. In fact there is no 'right' answer but the opportunity to form a well thought out probable answer." The problem includes making estimates on the cost of the food, what each person might eat, and the total cost for the order. Although Tara developed this problem she offered no extensions or adaptations to it.

Laurie, on the other hand, created one of her 10 problems and also offered extensions to the problem. This problem provided students with a newspaper advertisement of a lost cat and the newspaper's classified ads prices. Students were asked to determine the cost of running the ad in the weekend edition of the newspaper. The problem requires students to decide on how to define what counts as a 'word' so that the total number of words in the ad and the cost can be determined. Laurie offered the extension of having students create their own advertisements, using abbreviations to cut costs, and then determining the cost of the ad.

3.1.4. *Using textbooks for teaching*

The four preservice teachers in our study chose to analyze the textbooks used in their assigned practicum classrooms. These were traditional texts in which a typical lesson is situated on a two-page spread and a topic is introduced followed by practice problems of varying degrees of difficulty. Overall, the preservice teacher's analyses tended to be more descriptive than analytic. They described how the lessons were sequenced, how the topics were introduced, and the types of problems offered to students.

Only Tara and Laurie provided a more in-depth analysis of their textbooks reporting that the texts claimed to have problem solving as a focus but upon closer examination they found the "text leaned toward teaching about problem solving rather than through problem solving" (Laurie). They also found situations in which lessons were introduced with scenarios that appeared to have little to do with the mathematical concepts introduced (e.g. ballet dancers and decimals) and they analyzed the textbook unit for its logical progression of ideas.

All four of the participants expressed surprise by what they found in textbooks. They commented on how different these texts looked like from what they remembered using as students. They felt these texts offered them enough guidance to begin teaching yet also the flexibility to adapt and modify their teaching to meet the diverse needs of their students. Before the textbook analysis assignment, however, Tara and Laurie commented that they had not before considered the textbook as a daily teaching resource. As Laurie stated:

> I had this picture of textbooks as sort of something that if you're going to go the textbook route, then it means that [your teaching is] very stale and you're going to be plodding through the textbook page by page just doing exactly what's in the book. So, I was really anti-textbook for a while there. As a new teacher I don't have the experience behind me to always come up with a fabulous lesson and I am really surprised with a lot of textbooks. There's some really good lessons in them. (*Laurie, first interview*)

What we found interesting is how engaging in analysis of a textbook sparked a re-consideration of the participants' views about textbooks and how these might be used. Tara and Laurie, two preservice teachers who adapted and developed problems for their collection of problems assignment, struggled between wanting to use the textbook for teaching, on the one hand, and feeling guilty that using a textbook implied a lack of professionalism or creative teaching. Laurie's comment about not having the experience to "always come up with a fabulous lesson" implies that fabulous lessons are those that are personally developed or created "from scratch." Like the preservice teachers in Ball and Feinman-Nemser's (1988) study, Tara and Laurie drew from their own personal experiences as students

learning mathematics from textbooks and the implicit messages received from their teacher education coursework about teaching with textbooks to construct the image that teaching with textbooks was not good teaching.

The textbook analysis assignment, however, prompted these preservice teachers to reconsider the worth of textbooks. They began to see the text as offering them structures for what and how to teach, and they saw the textbook as relieving them of always creating original lessons in their teaching. All four preservice teachers began to consider the text in terms of its usefulness to the teacher and for students. Matt and Elaine focused on the ability of the text to motivate students. For Matt, textbooks were a source of problems for students to practice and do homework. For Elaine textbooks were a tool for discipline and motivation. "Textbooks," Elaine said, "keep students on task. Using the book would force students to work harder when confronted with the possibility of carrying it home to finish up their work."

With an opportunity to examine mathematics textbooks and in anticipation of their upcoming teaching practicum the study participants considered the textbook as a worthy and welcomed resource. It is worth noting that they did not comment on how or if they were concerned about how they would adapt or extend textbook lessons for their own purposes. Nor did they seem to connect the collection of problems assignment and their work at adapting problems with their analysis of textbooks and how the textbooks might be used. We wondered how prepared these assignments actually left preservice teachers as they entered their practice teaching.

3.2. *Using texts in deciding what and how to teach during teaching*

Observations of instructional practices and remarks made during the second set of interview sessions indicate that for each preservice teacher the mathematics textbook became the curriculum guide. The textbook therefore played a strong role in helping Elaine, Laurie, Matt, and Tara decide what and how to teach mathematics to their students during the practicum setting. To a certain extent each of the preservice teachers followed or covered the material in the texts although they did so in qualitatively different ways. From our analysis of the data we suggest that Matt taught in a way that adhered to the textbook and teacher's guide. Tara and Laurie attempted to teach in ways that elaborated upon the textbook lessons and suggested activities, while Elaine used the text to create her own units of study. Our classification of these preservice teachers' approaches to using and interpreting textbooks is summarized in Table II. We follow this summary with a more detailed discussion of each approach.

TABLE II
Approaches by preservice teachers for interpreting and using textbooks in their teaching

Approaches to using textbooks	Characteristics of use	Preservice teacher
Adhering	Accepts text as the authority for what and how to teach Adheres to one main curriculum resource Expects the text to provide routines/structures for students and teacher Makes few or no adaptations to lessons, tasks, problems, exercises in text. If adaptations are made they are superficial (contextual rather than conceptual) Does not see self as a resource	Matt
Elaborating	Considers text as a guide for what and how to teach Considers the text as the main resource but elaborates it with other resources Elaborates and extends textbook lessons, tasks, problems, and exercises Makes conceptual and contextual elaborations Sees self as a resource	Laurie/Tara
Creating	Examines text with a 'critical eye' for its potential and limitations in deciding what and how to teach Considers the text as one of many resources for teaching Creates problems and questions using the text to stimulate ideas for the structure, sequence, and context of lessons Adaptations are conceptual Sees self as a knowledgeable resource for designing problems	Elaine

3.2.1. *Adhering to the text*

Matt followed the seventh grade textbook closely with very few deviations from the text's suggestions for students or from the guide's recommendations for teachers. During classroom instruction, Matt carried the teacher's guide physically with him throughout the entire mathematics lesson. He began his lesson with the teacher's guide in his hand and by asking the students to pull out their textbooks. After leading his students step-by-step through the lesson as outlined in the book he then concluded the lesson by asking students to complete questions 2 through 9 for homework.

Reflecting upon the lesson, Matt mentioned that he used the teacher's guide because "sometimes I don't have the time to look for other stuff and I'll just go with the lesson that's in the guide." Moreover, the textbook, said Matt, is "time efficient" as well as "teacher efficient." Matt also admitted that he was using the textbook more than he thought he would during the practicum and "maybe perhaps more than it should be used." But this reliance, said Matt, was mainly because "it [is] hard to find other information, other resources. . . . Instead of forming my own lessons and knowing what I want to teach . . . I'll follow the textbook."

Although Matt adheres to the text in deciding what and how to teach he was also somewhat dissatisfied with the textbook's lack of connections between the mathematics presented and the possible real-life situations in which the mathematics may be found or used. As Matt stated:

> I don't think they [textbooks] have enough relating effect to real-life and how it comes into real-play . . . who cares what's a prime number and what's not . . . there's other examples of that too, like geometry, you know, it [the textbook] doesn't really tell you why you need to know it. . . . I sat there last night for half an hour trying to think of a way that I could tell them [the students] why prime numbers are important to use. (Matt interview 2)

Even though Matt seemed somewhat dissatisfied with certain aspects of the textbook and its use in deciding what and how to teach at this time, the text does cause him to question why he is teaching various concepts to students. However neither the textbook nor the teacher's guide helped him answer either from a mathematical sense or an application perspective why particular content is important to teach. As a result he was not able to address these concerns and in some instances even recognize in his pedagogical decision making process. Using the textbook to direct what and how mathematics should be taught was the most efficient and beneficial method for both himself and his students. The textbook Matt stated, "has great introductory activities . . . it's really good, the students enjoy it and it covers what's in the curriculum." Furthermore, projecting into the future as a beginning teacher Matt did not foresee changing what he was currently doing.

3.2.2. *Elaborating the text*

Similar to Matt, Tara and Laurie also closely followed the sequence of lessons as suggested in the students' mathematics textbooks or teacher's guide. To illustrate we describe Tara's approach, which differs from that of adherence in that she tended to elaborate upon the textbook lessons in ways that she thought would make her lessons more meaningful and interesting for her students.

From the interview sessions and observation of Tara's instructional practices we learned that in deciding what and how to teach Tara tried

to not follow the textbook "page by page" but instead tried to embellish the textbook by bringing in some "outside things." As she said "I think the textbook helps me decide what and how to teach something. But I think you'd have to know first what you want to teach and what's required and you can see what can help you in that and what you would have to pull out from somewhere else." For Tara it was important to be able to supplement the textbook lessons with "things from all different sources."

We observed Tara in a combined Grade 3/4 class teaching the first lesson in a unit on measuring and classifying angles. She began with a lesson from the text, photocopied so that all students could have a copy as there were not enough texts in the classroom for all students. The textbook page introduced the idea of an angle through reference to the hands of a clock. Using pictures in the book students were then asked to name various angles formed by the hands of a clock as a right angle or as angles smaller or greater than right angles. Rather than looking at pictures in a book about angles, Tara thought it would be more meaningful for students to measure their own angles. So Tara provided students with carpenter squares and suggested students measure the angles of their tables and chairs with the woodwork square. After students recorded their results on their sheets, the second question asked them to again name the angles formed by the hands of a clock using drawings of clocks on the paper. In addition to this she asked students to build their own clocks providing them with a face and hands that they could cut and attach to the clock.

Tara did not feel this lesson went well. She noticed students were not on task and that many were lost because she needed to re-explain the task to many groups after introducing it to the whole class. In preparing the lesson she recognized the difficulty of the content and the abstractness of the concept and therefore wanted to make the lesson more tactile for students. Yet she admitted "I thought to myself this is a neat way to actually make angles [using a clock] but then when I think about it why would you think about it with [only] a clock. Why wouldn't you think about it [angles] with a table or block?" Tara considered the angles formed by the hands of a clock to be as abstract as an angle formed by two rays drawn on a piece of paper. "I think the clock thing is confusing," Tara stated, "to go from an angle on a clock, to looking at it on a table [the angle formed between a wood block and the table], I think that is difficult." For Tara the angle formed by the hands of a clock, although it's representation was most like the pictures of angles that students would draw in following lessons, did not help her or the students deepen their understanding of what counts as an angle. Thus, Tara questioned why one would introduce the concept of angles to students by referring to clock hands.

Tara's attempts to elaborate her textbook lesson were based on her desire to make math less abstract and more meaningful for her students. In her thinking about how the textbook introduced students to angles and how she might elaborate on it she questioned the sequencing of the lesson and the depth of understanding needed in order to help students connect abstract mathematical ideas with what they see and experience. Connecting the concept of how angles can be formed in three-dimensional space with how they might be represented two-dimensionally is complex. Tara's attempts to adapt the textbook lesson brought these questions to the foreground. However the text, as Tara notes, did not help her answer or help her investigate the questions that surfaced for her as she planned her teaching. The mathematical language and abstract representation of angles remained questions for her.

3.2.3. *Creating text*

A third approach to deciding what and how to teach involved using the text as inspiration for creating text and lesson activities. Elaine, for example, taught in a fourth grade classroom in which individual work from the mathematics text was well established. Elaine's cooperating teacher had developed "a system," as Elaine called it, which allowed students to complete pre-tests on their knowledge of particular mathematical topics and then to work on individualized programs based on the results of these tests. Although Elaine initially envisioned herself teaching and adhering to the text and to use the text as a management or discipline tool to encourage students to complete their work, she soon found that a focus on textbooks as she saw in her practicum classroom was boring and uninspiring for students. Elaine therefore began to use the text as a source of ideas, a source that would help her imagine other ways in which students might engage in mathematics. Images and photos in the text helped her consider how she could develop lessons that might help students experience mathematics beyond the pages of the textbook.

During her practicum Elaine was responsible for teaching a geometry unit to her fourth graders. Although students in her class continued to follow the individualized textbook study approach, Elaine interrupted that study with lessons she created. For example, a textbook picture of a student folding a flag to illustrate the concept of 'line of symmetry' inspired an idea for her to bring into class several large flags for students to fold. Students participated in folding flags in various ways that would help them understand what made and did not make a line of symmetry. They further examined the flags for designs, graphics, or emblems within the flag that were symmetrical and tested their thinking by folding. Students participated in posing questions that they were then able to test.

In creating this kind of task for students Elaine was inspired by students' questions and wondered more about how this mathematical content (symmetry) was and could be connected to other content. She considered how student questions and discussions could be a source for designing lessons. For example, in the folding flags activity she noticed that students were using the term "flip" to mean both a rotation and a flip over. But this did not seem to stand out for her until she began developing a next lesson on translations and flips.

Using the textbook as a way to initiate her planning for this lesson she realized that what her students were saying differed from the mathematical language in the text. Therefore to help her students understand the concepts of translation, turns, and flips she used dance routines with the students to demonstrate 'sliding steps' (translation) and 'turns' (rotation) and using the idea of flags flapping in the wind to talk about flips as flips over a line rather than flips around a point. Although the textbook did not help Elaine respond to the different ways in which everyday language interacts with mathematical language, creating lessons stemming from the text helped in deepening her own understanding of this difference and the importance of listening to students' mathematical talk.

In summary we found that the preservice teachers in this study tended to use curriculum materials in deciding what and how to teach in three different ways: adhering to the text, adapting the text, and creating text. The textbook offered them a place to begin in their planning of mathematics lessons. It also offered opportunities to question what and how mathematics could and should be taught. Using multiple textbooks and resources provided a variety of ways of considering and approaching a topic for instruction. Adapting the textbook initiated questions for preservice teachers around sequencing, mathematical language, and mathematical abstraction. Creating text brought forth opportunities to consider connections within and beyond mathematical topics.

3.3. *Curricular and pedagogical decision-making: Affordances and constraints*

There are some striking similarities and differences in these preservice teachers' interpretations and uses of curricular materials both across all cases but also within each case, particularly when their ideas prior to teaching are contrasted with their views and practices while teaching. For instance, during their course work Matt and Elaine expressed similar initial ideas about how they might use textbooks in their teaching, yet during their teaching practicum they had two very different approaches.

Of the four preservice teachers Tara and Laurie were the most creative during their campus course work in adapting and creating problems that could be posed to students, while during the practicum they relied more on the textbook for guidance and support and chose more often to elaborate textbook lessons than create their own. On the other hand, Matt's selection of problems collected during course work was very similar to the kinds of problems he posed to his students during the practicum. Although these results point to the complexities of connecting learning and teaching within university coursework and practicum settings we find these results puzzling.

As we try to understand what might account for the differences in using and interpreting curriculum materials before and during teaching, we are drawn to examine the nature of the learning opportunities offered to the preservice teachers. First let us consider the differences across the four preservice teachers during their practice teaching and then move to examine this in light of the differences within cases considering the university setting. The interpretation and use of curriculum materials do not occur in isolation; how teachers decide what and how to teach is mediated by the classroom context. Following other research (e.g. Hargreaves, 1994; Fullan, 2001) that highlights how school structures influence teacher decisions, we were curious to explore how preservice teachers perceived the classroom context.

When we asked preservice teachers during their practicum what seemed to influence their choice of how they used textbooks they each spoke about *the nature of their classroom* which included their co-operating teacher and the kinds of students in the class. In those classroom situations in which the sponsor teacher was perceived by the preservice teacher to be a flexible user and creative developer of instructional activities then the preservice teachers were also able to become, to some extent, curriculum elaborators and creators. If, on the other hand, the co-operating teacher was perceived to rely on the textbook in deciding what and how to teach then it was generally expected by the preservice teacher that he/she should do the same, as was the case for Matt. However, it is also this expectation that can spur preservice teachers, such as Elaine, to want to teach differently.

Before the practicum Elaine envisioned teaching with the text and using it to control student behaviour. Working with students during her practicum who routinely followed the text made Elaine consider alternative approaches. She attempted to follow the text but to also use it to create and invent lessons that addressed the students' lack of engagement with mathematics. It should be noted that Elaine's efforts to do this were supported by her sponsor teacher, perhaps partly because these changes Elaine proposed interrupted but did not disrupt the textbook system that the co-operating teacher had developed. While previous research has found that teachers'

efforts to change their mathematics teaching is related to the support they receive from colleagues or resource collaborators (Ferrini-Mundy, 1998; Heaton, 2000; Stein et al., 2000) our research makes the more specific claim that preservice teachers' perceptions of the classroom context are important for them in deciding what and how to use curriculum materials.

The preservice teachers also talked about their familiarity and *understanding of the content* as an influencing factor to their curricular approaches. All four talked about ways in which the textbook had raised questions for them about the meanings, connections, and motivations of the content they were teaching. When their textbook could not answer their questions they questioned their own understanding of mathematics and felt constrained in deciding on what content and how they would teach it.

Matt and Tara for example noted that they did not have difficulty selecting what was important to cover or leave out in other subject areas that felt more familiar and in which they felt more competent. Laurie also stated that she felt she did not understand many of the mathematical concepts well enough to be able to teach them and therefore used her students' textbooks and teacher's guide to familiarize herself with the content she needed to teach. This is consistent with other research findings about the complex interaction between subject matter knowledge and teaching practice in beginning teachers (e.g., Eisenhart et al., 1993) and points to the need to further investigate this relationship but also the need to investigate how teachers' knowledge relates to the ways in which they use and interpret mathematics texts.

The availability and *access to resources* was another reason offered by the preservice teachers to explain their approach to curriculum materials when teaching. All four preservice teachers found that their classrooms offered little in terms of access to various curriculum materials that they could use to help them make sense of what they were expected to teach. Matt, for example, mentioned that his difficulty in finding information to enrich or personalize mathematics made him rely more heavily on the textbook as the sole resource for his teaching than he had anticipated. All four preservice teachers recognized that various textbooks offered different approaches to presenting content and that consulting more than one text often helped them frame an understanding of the mathematical concepts and pedagogical questions related to the topic. However these particular textbooks, which are not designed for the purpose of teacher learning (Ball and Cohen, 1996), did not provide them ways to answer many of the 'learning how to teach' questions that arose in the context of their teaching.

What we find interesting about these results is the differences in how all four preservice teachers were able to use the limited resources that were

available to them. Elaine, for example, had no more access to resources than the other preservice teachers, yet she was able to take what she had and draw upon her own experiences to create interesting lessons for her students. Unlike the preservice teachers in Ball and Feinman-Nemser's (1988) study who were found to favour their own ideas over the textbook's about what and how mathematics should be taught, Elaine used the text to stimulate her ideas about how mathematics could be taught with her students in mind.

If we move now to examine the preservice teachers' learning opportunities during their mathematics education coursework we see that the coursework provided them with assignments that encouraged them to select, adapt, and critique problems and textbook lessons. The course emphasized teaching mathematics through problem solving and with the exception of Matt, the preservice teachers collected and adapted rich learning tasks for their future classrooms. We also see that the text analysis assignment encouraged the preservice teachers to reconsider some of their ideas about the textbook and how they might use it.

Although the preservice teachers had opportunities to analyze curriculum materials during their university coursework it was their attempts to adapt and make sense of curriculum materials while they were teaching that spurred them to question their own understanding of the mathematics and how it could be taught. Our analysis of the data suggests that it was not the mathematics education coursework that prompted them to question their assumptions about their own understanding of mathematics, about how they should sequence topics, about how they might engage students' interests, how students might respond, and how the textbook might be used. Although the course may have had some part in stirring up questions around these issues, our findings indicate that it was preservice teachers' efforts to make changes to the textbook lessons while they were teaching that challenged their assumptions about mathematics teaching and learning. However, once in the practicum, they found the textbook less useful in helping them develop responses to the questions they had.

It is important to recognize that both of the course assignments were completed as individual assignments rather than as a collaborative enterprise in the teacher education course. This could explain why the assignment, unlike the ways in which teachers are reported to engage with texts in transformative ways in the research literature (e.g., Ma, 1999; Reys et al., 1997), failed to raise the kinds of questions that were raised when the participants were teaching. But another explanation for these results may lie in the complicated relationship between learning in teacher education courses and the practice setting (Ebby, 1999).

Notice that if our study had concluded following course work we would have high hopes for Tara and Laurie and less for Matt and Elaine to become creative users of texts during their practicum teaching. Similarly, if our study had taken place only at the teaching practicum the conclusions would be quite different. In that case we would find interesting that only Elaine has created a practice that does not emulate her collaborating teacher's but instead is more aligned with visions of teaching promoted in her teacher preparation courses. We therefore find intriguing that our results complicate popular claims about the 'wash out' effect of the student teaching experience. That is, claims that what preservice teachers learn during teacher preparation is 'undone' when they set foot in real classrooms. Our study provides further evidence that preservice teachers can learn a great deal while they are teaching (Ebby, 1999) even in classrooms that do not exactly model 'best' practices.

A further interesting finding for us is the case of Matt whose mathematics education coursework had little influence on his ideas for how he would teach mathematics. He had selected procedural problems with low cognitive demand for his collection of problems assignment and then engaged his Grade 7 students in similar problems during the practicum. In our interviews with Matt he indicated that he was successful in and enjoyed mathematics because of its procedural nature. We see this as evidence that teacher beliefs about teaching and learning influence their decisions about what and how to teach (Putnam, 1992; Thompson, 1992). Matt's success with learning mathematics procedurally influenced his ideas for how he would teach his own students. Yet, as with the other preservice teachers, we find that in Matt's attempts to use the textbook with his students he was also prompted to question his initial assumptions and understandings of mathematics and mathematics teaching.

3.4. *Conclusion and implications*

The findings of our study suggest that preservice teachers look to textbooks for answers to multiple questions. Although some preservice teachers in this study stated before their practice teaching that they felt the textbook would help them control and manage learning, once in the practicum they found the textbook raised more questions for them than it answered. How should a teacher teach from a text when a classroom has only enough texts for some but not all of the students? Why should a particular topic be taught at all? How can a teacher use a text with learners of diverse interests and abilities? How might students respond if the task is adapted? These are questions preservice teachers asked themselves as they planned lessons for their students. And although the textbooks did not help them answer these

questions using textbooks did help preservice teachers think about these important issues.

Previous research has focused on examining how teachers use reform-based curriculum materials and the opportunities for learning using these materials provides (Remillard, 2000; Reys et al., 1997, 1999). Our study extends this research by focusing on preservice teachers and their use of curriculum materials that are most commonly found in mathematics classrooms. While most of the curriculum materials that preservice teachers work with and will be expected to use in their own classrooms are not necessarily designed for teacher learning (Ball and Cohen, 1996) our findings suggest that these materials can nevertheless help raise questions for preservice teachers. This is encouraging and until more text materials for teacher learning are developed, teacher educators might consider how the use of and analysis of traditional texts can be opportunities to initiate and support preservice teacher learning. Although prospective teachers have yet to develop the kind of experience needed to create lessons which meet their and their students' needs, the teacher education program can be a beginning to help preservice teachers recognize the potential role of texts as well as provide alternatives to the text in teaching and learning mathematics.

As we imagine how we might structure such opportunities in teacher preparation programs, it is important to consider that the classroom setting acts as a powerful context for deciding what and how mathematics can be taught and the role mathematics textbooks might play. In our study, interpreting and using curriculum materials while teaching engaged preservice teachers in questions that did not arise for them while analyzing curriculum materials during their university coursework. This suggests careful consideration to how we might provide a supportive environment for preservice teachers to help them learn with and from textbooks during both their coursework and their teaching practicum.

Another consideration is how we might move beginning teachers, such as Matt, from adhering to the text to adapting the text in ways that are based on sound pedagogical judgments rather than opinions about what might be considered as merely more fun for students. The analysis and adaptations of textbook lessons, we suggest, offer school-based and university-based teacher educators opportunities to help preservice teachers consider the strengths and weaknesses of particular adaptations, designs, or representations from mathematical, curricular, and pedagogical perspectives. These assignments also provide opportunities for teacher educators to gain insight into what preservice teachers find important and how we might help them learn to select and pose mathematical problems (Crespo, 2003; Nicol, 1999) that engage students mathematically.

This study also provides insight into considering what preservice teachers need from curriculum materials. Using textbooks to learn the mathematical concepts and principles they will be teaching can be problematic as textbooks do not often provide the conceptual understandings that underlie many of the mathematical principles that preservice teachers are expected to teach. Therefore, to learn from a textbook from which the concepts are to be taught does not provide preservice teachers with the necessary background knowledge to know when to focus on certain ideas or when to elaborate on others, how the concepts are connected to other principles or even why the concepts are important to learn. Learning to teach from textbooks, although they may provide some insight into various mathematical principles, can also perpetuate an algorithmic style of teaching.

In order to help preservice teachers pursue their questions about what and how to teach, textbooks need to offer them more elaborate explanations for why particular topics are presented in the order and sequence they are in the text. Further, teacher's guides could provide suggestions and rationale for how to use textbooks with diverse learners. They could provide support for beginning teachers' investigation of the mathematics they are teaching by providing some discussion of the important mathematical ideas that are embedded in the tasks and activities. This needs to be done in ways that are engaging and interactive. Providing more written text about multiple ways in which a concept could be taught is not likely to stir beginning teachers' interests and intellect in examining these materials for teaching.

Ma (1999) writes about how an investigation of curriculum materials provides opportunities for experienced teachers to develop their understandings of mathematics for teaching. What might we do for beginning teachers? We suggest that an investigation of curriculum materials needs to be an ongoing practice for beginning teachers. Preservice teachers need continued opportunities to learn how to, as Remillard (2000) suggests, "read" text or use texts in developing curriculum. They need opportunities to ask what the consequences are of adapting or not adapting certain materials. We concur with Ball and Cohen (1996) that teachers and texts need not be in opposition; that texts can offer opportunities for teacher learning but that preservice teachers need continued support to foster learning that will carry them through the practicum and into their beginning years of practice.

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