Teachers’ Senses of Obligation to Curricular Messages

Christy D. Graybeal
Hood College1, Frederick, Maryland, U.S.A.
graybeal@hood.edu

Abstract
Whether they are acknowledged or not, resources such as textbooks, curriculum guides, assessments, and professional development programs present messages about what is most important for students to learn and how students can best learn this. At times teachers feel obligated to enact these messages, but at other times they feel free to ignore these messages. When do teachers feel obligated to follow messages that they interpret from resources and when do they feel that they can ignore these messages? Through survey, observation, and interview this qualitative study explored this question. The messages that five experienced, elementary certified, middle school mathematics teachers interpreted and the ways in which these messages related to their beliefs and practices were studied. When the teachers were in agreement with their interpretations of the messages, they usually followed through with these messages in their practices. Surprisingly, when the teachers disagreed with the messages, their practices were still sometimes reflective of these messages. It seemed that this was because the teachers felt obligated to enact these messages. This sense of obligation was most apparent when there were clear and consistent messages both within and across resources. Teachers felt that they could use their discretion and ignore vague, inconsistent, and controversial messages.

Keywords: Professional discretion; Mathematics teachers; Educational resources; Curriculum policy

Introduction
Some suggest that teaching is one of the most decision-laden professions. Danielson (1996) estimates that teachers make an average of 3000 non-trivial decisions per day.

When making decisions about what and how to teach, among other things, teachers draw on contextual factors, curricular materials, and personal beliefs, experiences, and

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knowledge (Drake & Sherin, 2006; Remillard, 2005; Tarr, Chávez, Reys, & Reys, 2006). Remillard (1996) refers to “the range of tools (personal, collegial, published, structural) that teachers bring to, and draw on in their teaching” as resources (p. 90). Whether they are acknowledged or not, resources such as textbooks, curriculum guides, assessments, and professional development programs present messages about what is most important for students to learn and how students can best learn this (Goldenberg, 1999; Hill, 2001; Spillane, Reiser, & Reimer, 2002). These messages are usually not explicit (and are therefore different from policies), but they can normally be rephrased as statements that begin with “Teachers should…”

Goldenberg (1999) points out that frequently the authors of resources are not even aware of these messages; thus these messages may not be given the thought, planning, and careful analysis that they deserve. Furthermore, each teacher can interpret the same resource differently.

Frequently teachers interpret these messages to be competing and/or conflicting messages. This is especially true for teachers of mathematics. It is unlikely that there has ever been or ever will be perfect alignment among the messages present in mathematics resources, but it seems that the recent emphasis on both reform-oriented teaching (American Association for the Advancement of Science [AAAS], 1989, 1993; National Council of Teachers of Mathematics [NCTM], 1989, 1991, 1995, 2000, 2006; National Research Council [NRC], 2001) and high-stakes testing (No Child Left Behind Act, 2001) has increased the number and intensity of competing and conflicting messages regarding mathematics instruction in the United States of America.

In this article results of a study focusing on the messages that middle school mathematics teachers interpreted from curricular resources are shared. These
interpreted messages were compared to the teachers’ beliefs and observed practices. In particular, attention was paid to teachers’ senses of obligation to messages. When did teachers feel obligated to follow messages that they interpreted in resources and when did they feel that they could ignore these messages?

**Relevant literature and rationale**

Despite the many constraints placed on them, teachers have significant influence over what and how they teach (Cohen & Hill, 2000; Cuban, 1995; Lipsky, 1980; Wills & Sandholtz, 2009). Mathematics teachers who are using the same curricular materials can enact them in dramatically different ways and afford their students very different experiences (Chávez-López, 2003; Chval, Grouws, Smith, & Ziebarth, 2006; Kilpatrick, 2003; Remillard, 1996; Schwille et al., 1982). Teachers use their professional discretion (Boote, 2006) to mediate among competing demands while meeting the needs of their students.

Although it was recommended as a key area of needed research by the National Research Council (2002), few studies have examined how mathematics teachers interpret or make sense of policy messages. The two most relevant studies were conducted by Hill (2001) and Berk (2004, 2005). Hill (2001) examined how a group of teachers on one school district’s mathematics curriculum writing committee interpreted state standards. She found that language plays an important role in policy interpretation and that there is often a disconnect between how authors and readers use words such as *explore, construct, and understand*. Thus, authors’ intentions are sometimes lost as readers make sense of the messages. Berk (2004, 2005) followed a group of 14 middle school mathematics teachers as they read and discussed *Principles and Standards for School Mathematics* (NCTM, 2000). She found that the teachers came to view the document from multiple lenses: as a *warrant* for their current beliefs
or practices, as a lever for effecting change, as a tool for their own learning, as a springboard for rich discussions with colleagues, and as a curriculum map.

Spillane, Reiser, and Reimer (2002) developed a cognitive framework to characterize how implementing agents\(^2\) make sense of and implement messages. This framework focuses on the agents’ existing cognitive structures (including knowledge, beliefs, and attitudes), their situation, and the policy signals. Their framework uses individual cognition theories, situated cognition theories, and theories about the role of representations to explain why different agents interpret the same messages differently and why agents can misunderstand new ideas as familiar and hinder change. It also explains why agents may focus on superficial features and miss deeper relationships and why people are biased toward interpretations consistent with their prior beliefs and values. They argue that when policies are not implemented as intended it is not because implementing agents reject messages, but rather that it is because they understand them differently than policymakers intend. Although they mention that implementing agents often face contradicting messages, it seems that their model assumes that the messages present a consistent vision. It is unclear if their framework explains how teachers deal with competing or contradictory messages.

Few studies have examined teachers’ interpretations of incongruencies among resources. The two most relevant studies found that teachers tend not to notice incongruencies of messages among resources. Tomayko (2007) surveyed members of the Maryland Council of Teachers of Mathematics about the working conditions, challenges, and tensions they experience; 252 teachers completed the survey. Most

\(^2\) Because Spillane, Reiser, and Reimer (2002) use the term “implementing agents” it is used here. In other places in this article the use of the word “implement” is purposefully avoided in order to emphasize the participatory nature of teachers with curricular materials.
were middle school or high school mathematics teachers. She found that more than 80% of the surveyed teachers agreed or strongly agreed with the statement “My school and my district have the same values regarding math content” (p. 79). Approximately 75% of the surveyed teachers agreed or strongly agreed with the statement “My school and my district have the same philosophy regarding math instruction” (p. 79). Similarly, although Hill (2001) and the writers of some of the resources saw significant differences in the messages in the different resources the teachers in her study were analyzing, the teachers did not appear to notice conflicts in messages. She attributed this to “humans proclivity to see order, not disorder, in their environments” (p. 313) and the teachers’ blind acceptance of the textbook authors’ claims of alignment with state standards.

Most studies of message incongruence have focused on the incongruencies between resources and teachers. Many studies have found that teachers are frequently not in agreement with the messages they interpret from their resources. For example, in a nationwide survey of over 4000 teachers’ attitudes and opinions about state mandated testing programs Abrams, Pedulla, and Madaus (2003) found that “teachers are uncomfortable with the changes they feel they need to make to their instruction to conform to the demands of the state testing program” (pp. 23-24). Similarly, almost half of the teachers surveyed by Tomayko (2007) indicated that they agreed or strongly agreed with the statement “I am philosophically at odds with ways that I am expected to teach math” (p. 79).

Although there are often competing and/or conflicting messages both within and among resources, few studies have examined how teachers respond to these incongruencies. For these and other reasons, further study of teachers’ interpretations of and responses to resources, especially with regard to teachers’ beliefs, was
recommended by Remillard (2005), Tarr et al. (2006), and Thompson (1992). This study adds to our understanding of these issues.

**Overview of the study**
This research study examined the messages about mathematics and mathematics teaching that five elementary certified, middle school mathematics teachers interpreted from their students’ textbooks, school district’s curriculum guides and assessments, state’s assessments and curriculum framework, a master’s degree program in which they were enrolled, and other resources which the teachers felt were significant influences on their teaching. It also examined how these messages related to the teachers’ beliefs and observed classroom practices. Particular attention was paid to messages with which the teachers disagreed. When did the teachers feel obligated to follow messages that they interpreted in resources? When did they feel that they could ignore these messages? (For a more detailed description of this study, see Graybeal, 2008.)

**School district**
The teachers involved in this research study work in one of the largest school districts in the United States of America. There are over 130,000 students in this school district. Just as in many other large school districts, in this district major decisions about the formal curriculum are made by the central office staff, not individual teachers or schools. Thus, all middle school teachers in the district are required to use the same textbooks, follow the same curriculum guides, and give their students the same formal assessments.

The school district offers six mathematics courses in its middle schools: a 6th grade mathematics course, a 7th grade mathematics course, an enrichment course in 7th grade mathematics, an 8th grade mathematics course, high school Algebra, and high
school Geometry. For each of these courses, the school district’s central office staff has written a curriculum guide. These curriculum guides are quite detailed. For example, the 6th grade mathematics course’s guide is over 600 pages long. Each guide contains information about the scope and sequence of the curriculum as well as detailed expectations about each lesson. Some lessons have multi-page lesson plans. Additionally, pre-assessments and post-assessments for each unit of study are included. These assessments are required to be administered to the students at specific times of the year and the teachers must submit scores for each of the questions on the assessments for each student to the central office by pre-determined dates. These scores are then sent to the school district’s superintendent’s office for review.

The school district has adopted textbooks published by Glencoe/McGraw-Hill for all of its middle school mathematics courses. Although the curriculum guides are loosely written around these textbooks, the guides do not follow the textbooks’ sequence of lessons and the guides add lessons to and remove lessons from the textbooks. Additionally, the school district’s curriculum guides frequently recommend the use of other instructional resources such as NCTM’s Navigations series and Cuisenaire’s Super Source series (ETA/Cuisenaire, 1996a and 1996b).

Some of the disparity between the school district’s curriculum guides and textbooks may have resulted from the school district’s controversial middle school

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3 Although some of these courses are named by grade level, not all students enrolled in the 6th, 7th, or 8th grade courses are in the given grade; younger students may take the courses as well. For example, it is not uncommon for 6th graders to take the 7th grade mathematics course or even the enrichment course in 7th grade mathematics. In fact, students are encouraged to take more advanced coursework; by 2010 the school district aims to have more than 75% of its students successfully complete high school Algebra by the end of 8th grade. In 2007, almost 60% of the school district’s students successfully completed high school Algebra by the end of 8th grade.
mathematics textbook adoption process. The school district reported that they used work done by the AAAS to develop a set of evaluation criteria. A committee consisting of teachers, specialists, and the district’s mathematics supervisors used those criteria to identify two textbook series for further consideration. The two series were *Connected Mathematics* (Lappan, Fey, Fitzgerald, Friel, & Phillips, 1998) and the Glencoe/McGraw-Hill texts.\(^4\) At around this time, several letters to the editors of local newspapers were published. These letters, written by parents of school district students, other local citizens, and national figures in mathematics education, vigorously argued against the adoption of *Connected Mathematics*. After further consideration, the committee recommended the Glencoe/McGraw-Hill texts for adoption.\(^5\)

*Masters degree program*
As a result of recent reform movements in mathematics education and increases in accountability through federally mandated tests, middle school mathematics teachers in this school district are being asked to teach more advanced mathematics content and are being asked to teach it differently than they have in the past. Although most middle school mathematics teachers in this school district teach only mathematics courses, many are certified in elementary education (grades 1-8) and have taken only the mathematics courses required to become certified in elementary education. As a result, a new master’s degree program was designed for these teachers. The primary goals of the program were that the courses would improve teachers’ subject matter knowledge and pedagogy as well as encourage them to reflect on issues related to the

\(^4\) It is interesting to note that in its evaluation of middle grades mathematics textbooks, AAAS (2000) described *Connected Mathematics* as excellent and the Glencoe/McGraw-Hill texts as unsatisfactory.

\(^5\) The Glencoe/McGraw-Hill are among the most widely used mathematics textbooks in the United States of America.
philosophy of mathematics and mathematics teaching. Throughout the program, teachers were asked to think deeply about their own beliefs about mathematics and mathematics teaching. (For more about this program, see Badertscher, 2007.)

Participants
In April 2007 all members of the first cohort of the master’s degree program described above were invited to participate in this research study. Five teachers (Amelia, Beth, Emma, Kathleen, and Sarah)\(^6\) responded that they were interested in participating. All five of these teachers were elementary certified, but taught middle school or high school mathematics courses in a middle school. At the time of data collection, the teachers each had between 8 and 15 years of teaching experience.\(^7\)

Data sources
The data sources included the teachers’ responses to the Teachers’ Beliefs about Mathematics and Mathematics Teaching inventory (Campbell, 2004), classroom observation notes, scores on the Reformed Teaching Observation Protocol (Sawada et al., 2000), and transcripts from interviews and post-interview conferences.

Beliefs inventory
All teachers enrolled in the master’s degree program completed the Teachers’ Beliefs about Mathematics and Mathematics Teaching inventory (Campbell, 2004) at three times over three years. This inventory is based on work done by Ross, McDougall, Hogaboam-Gray, and LeSage (2003). It focuses on the teachers’ beliefs about mathematics and mathematics teaching and is meant to provide a measure of reform-oriented beliefs. Teachers’ responses to this beliefs inventory were used as one measure of the teachers’ professed beliefs.

\(^6\) All teachers’ names are pseudonyms.
\(^7\) See Badertscher (2007) for more detail about Amelia’s and Beth’s mathematical experiences.
Middle school classroom observations

Each of the five teachers was observed teaching for at least three consecutive days in May 2007. Detailed observation notes were made of all middle school classroom observations. Additionally, Sawada et al.’s (2000) Reformed Teaching Observation Protocol (RTOP) was used to assess the degree to which each lesson embodied the recommendations and standards of reform-oriented teaching. This instrument was designed to reflect the recommendations and standards of the NCTM (1989, 1991, 1995), the NRC (1995), and the AAAS (1993) and it embodies a vision of reform-oriented teaching which is similar to the one depicted in Campbell’s (2004) beliefs inventory. When possible, middle school classroom observations were followed by a debriefing session. During these sessions, teachers were asked about the pedagogical choices made during the observed class session and what influenced these choices. These conversations were audio recorded and transcribed.

Interviews

In order to learn more about how the teachers interpreted the messages in the curricular resources, each of the observed teachers was interviewed individually. In the interviews, the teachers were asked about their teaching backgrounds and how they typically plan lessons. Additionally, for each of the curricular resources (their students’ textbooks, school district’s curriculum guides and assessments, state’s assessments and curriculum framework, the master’s degree program in which they were enrolled, and other resources which the teachers felt were significant influences on their teaching) the teachers were asked to talk about the messages they saw in the resources and how these messages fit with their own beliefs and practices. Interview questions included:
• How do you think the authors of [the resource] envision an ideal lesson’s design and implementation? How does this fit with your own vision of an ideal mathematics lesson?

• What do you think the authors of [the resource] think is most important for students to learn about mathematics? How does this fit with your own priorities for your students?

• What kind of classroom culture do you imagine the authors of [the resource] would want? How do you think they would want students and the teacher to interact? How does this fit with your own thoughts about student and teacher interactions?

Although each teacher was asked each of these questions about each of the resources, sometimes the conversational nature of the interviews led to tangential topics and not every teacher answered every question.

Data analysis
The observation notes and interview transcripts were used as the primary sources of data. These were analyzed using qualitative procedures described by Bogdan and Biklen (2003). First, all of the observation notes and interview transcripts were read and examined for trends. A preliminary set of codes was developed and the data were coded and re-examined for trends. After several iterations of reading and coding the data, 11 themes emerged: Concepts and procedures, Connections, Cooperative learning, Differentiation, Explanation, Manipulatives, Practice, Question types, Source of solution methods, Technology, and Timeline. These themes provided a way of grouping all of the data (including the quantitative data from Campbell’s (2004) beliefs inventory and the RTOP) by related topics. For example, all data relating to the use of technology by students or teachers was placed in the Technology theme.
Next, the teachers’ quotes about their interpretations of messages in the different resources were paraphrased. Whenever possible, words from the teachers’ vocabulary were used in the paraphrases, but quotations containing similar ideas were paraphrased in the same way in order to emphasize similarities in interpretations. For each of the paraphrased messages for each of the teachers, the relation between the message and the teacher’s beliefs and the relation between the message and the teacher’s practices was determined. The language used by the teachers when talking about the messages and the teachers’ professed beliefs as indicated on the Teachers’ Beliefs about Mathematics and Mathematics Teaching inventory (Campbell, 2004) provided evidence for the relation between the messages and the beliefs. Similarly, observation notes and, when applicable, the RTOP provided evidence for the relation between the messages and the practices.

**Findings**

In order to gain an overall view of how the teachers’ interpretations of messages in the resources were related to their beliefs and practices, the messages that each teacher talked about were compared to the teacher’s beliefs and observed classroom practices. Overall, 52 of the 92 interpreted messages were aligned with the teachers’ beliefs and practices; eight of the messages were aligned with the teachers’ beliefs, but not their practices; 19 of the messages were aligned with the teachers’ practices, but not their beliefs; 13 of the messages were not aligned with the teachers’ practices or beliefs. Table 1 summarizes these results.
It is not surprising that more than half of the messages (52 of the 92 messages) were messages with which the teachers agreed and which were reflective of their practices. This may be expected because teachers (and people in general) are often biased toward interpretations consistent with their beliefs and practices (Berk, 2004; Spillane et al., 2002). The eight messages with which the teachers agreed, but did not reflect in their practices are more interesting. It seemed that these were not enacted because the resources did not provide enough supports to the teachers to follow through with the messages in their teaching. The most interesting messages, however, were the ones with which the teachers disagreed. When these messages were reflected in their practices, why was this? Did the teachers feel a sense of obligation to enact these messages? Or, despite their efforts not to enact these messages, were they unable to do so? When the teachers did not enact the messages with which they disagreed, why was this? What was it about these messages that made the teachers feel that they could ignore them? The following sections focus on these questions.
Although these phenomena were observed with all five teachers, for the sake of brevity the following sections focus on Amelia. Amelia was selected because she was the most “traditional” of the five teachers and thus like many mathematics teachers in the United States of America. The examples come from four of the 11 message themes: Concepts and procedures, Question types, Source of solution methods, and Technology. These four themes were chosen because at least four of the five teachers in this study interpreted messages from each of these themes. Additionally, these themes provide examples of messages which Amelia felt obligated to follow and also messages which Amelia felt free to ignore. Together these examples help us understand Amelia’s sense of obligation to the messages she interpreted from curricular resources.

*Concepts and procedures*
Over the past century, the emphasis on concepts and procedures in mathematics instruction in the United States of America has swung back and forth repeatedly. For the first half of the twentieth century, mathematics instruction primarily focused on mathematical procedures. In the 1950s and 1960s the “new math movement” attempted to redirect attention to mathematical concepts. This was followed by the “back to basics” movement which again focused on procedures. In the 1980s and 1990s the “reform” movement again focused on concepts. In response to this, there have been more recent “back to basics” movements (NRC, 2001, p. 115). Although conceptual understanding and procedural fluency are not mutually exclusive instructional goals, many teachers feel that they are and that they must choose between the two. Despite recent efforts to reform mathematics instruction, most students in the United States of America receive instruction which “continues to
emphasize the execution of paper-and-pencil skills in arithmetic through demonstrations of procedures followed by repeated practice” (NRC, 2001, p. 4).

Amelia talked about messages about concepts and procedures in three resources. When asked how she imagines the State Superintendent of Schools might want her to teach, she said, that in order to answer the questions on the state assessments, you have to “focus more on the conceptual side than the procedural” (personal communication, November 2006). This was paraphrased as “Teachers should focus more on concepts than procedures.” When asked how she perceives the writers of the textbook *Mathematics: Applications and Connections Course 1* (Collins et al., 2001) would describe what and how students should learn, Amelia said, “they're definitely procedure” (personal communication, November 2006). This was paraphrased as “Teachers should emphasize procedures.” When talking about the master’s degree program, she said that this program has taught her to value more than students’ abilities to apply procedures. This was paraphrased as “Teachers should value more than procedures.”

Although some of these messages may seem to be conflicting, Amelia indicated that she believed in all of them. She felt that both concepts and procedures need to be emphasized. She even noted that she believed procedures are important even though this is not a widely accepted position. She said:

I feel like people think it's a crime to say that knowing how to do the procedure is important. I think that that [number sense] is important and I think you get that with the conceptual piece, but I also don't think that procedure is a bad thing. Like people would say procedural almost like it's a bad thing... I kind of don't think it's a – you know, like in conjunction with conceptual understanding. (personal communication, November 2006)

Although Amelia claimed to believe in the importance of both procedures and concepts, her classroom practices reflected more of a focus on procedures. For
example, she showed her students how to solve division by decimals questions by moving the decimal point in the divisor and dividend and then had her students practice the algorithm for homework. The next day she modelled decimal division with base-ten blocks on the overhead projector and then directed the students to work in small groups to practice solving similar problems and to make sure they arrived at the same answer as they would with the paper-and-pencil algorithm.

It is interesting to note that for the topic of decimal division she reversed the order of lessons that the school district and textbook recommend. Both the school district’s curriculum guide and the *Mathematics: Applications and Connections Course 1* (Collins et al., 2001) textbook have students use base-ten blocks to divide decimals (Lesson 4-6A) before learning the traditional algorithm of moving the decimal point in the divisor and dividend (Lesson 4-6).

When asked why she changed the order of the lessons, she said:

Sometimes I feel like – I never really know what's better, like what comes first the egg or the chicken (Laughter). Like sometimes, I feel like with our lower level kids that sometimes procedure first actually is more helpful to them when it comes to trying to understand the concept, the concept behind it and then I think some things lend themselves to the other way around. I don't know. I opted to go procedural with the division. They could relate to it with whole numbers. . . . (personal communication, November 2006)

Although Amelia was attempting to help her students understand the concepts by first gaining fluency in the procedures, it did not seem that once the students knew the procedure, they were interested in learning the concepts behind the procedure.

This focus on procedures may be because when Amelia was learning mathematics as a student, she felt that she focused only on procedures. But, as a teacher, Amelia made an effort to focus on both procedures and concepts. She said:

I feel that I learned procedure. I never learned meaning behind anything, but I always thought that I was very good at remembering my directions. . . . but you know, I'm changing, like things are making more sense to me. I
tell the kids all the time, like I understand fractions and decimals and all these other things so much more now because I am teaching them, which is why I try and have them talk to each other more and explain themselves more, and maybe teach each other – because I feel that’s how you kind of learn it. You know? So that to me has changed a lot, like I am trying to go away from procedure now. And now I feel like I am asking why more often…. (Amelia’s interview with Badertscher, September 2006)

Despite her belief in the importance of conceptual understanding, Amelia found it difficult to incorporate more of a focus on concepts into her teaching. She said, “I feel like I am confident in the fact that I am trying to do the right thing. But I am really lacking how to teach it conceptually in a lot of ways” (Amelia’s interview with Badertscher, June 2007).

The authors of *Mathematics: Applications and Connections Course 1* (Collins et al., 2001) might disagree with Amelia’s interpretation that they focus on procedures, but others agree with Amelia. In their evaluation of the textbook, AAAS said, “In some lessons, there are prompts in the margins that attempt to address prerequisites but these focus only on procedures. . . . There are few strategies to build conceptual thinking and no suggestions for correcting procedural errors” (2000, p. 119). Thus, this resource provided little support to Amelia as she tried to learn “to teach it conceptually” and her efforts were not enough in this instance.

**Question types**

One of the most prominent features of any curricular resource is the types of questions that it asks. Do the questions tell what operations to use or is that left to the readers to determine? Are the questions contextualized? If so, are the contexts realistic and/or meaningful to the students? Traditionally textbooks in the United States of America have emphasized computational questions devoid of contexts. As a result, students have had great difficulty in applying what they learn in a particular lesson to other situations both inside and outside of school. In order to help students succeed in
applying their knowledge to new situations, some have argued that students should learn mathematics in contexts similar to the situations in which the knowledge will be needed (Barab & Plucker, 2002; Greeno & Moore, 1993). Others have argued that mathematics questions need to not only be contextual, but that these contexts need to be relevant to the students’ lives (Gutstein, 2003; Secada, 1992; Tate, 1994). On the other hand, Goldenberg (1999) points out that “real life application” problems are not necessarily more interesting to or motivating for students than are “good puzzles.”

Amelia interpreted there to be messages about the types of questions she was supposed to ask her students in two of the resources that we discussed. When asked how she thought the authors of the *Mathematics: Applications and Connections Course 1* textbook (Collins et al., 2001) would describe what mathematics is about and how the authors think students should learn math, Amelia said:

> Everyone's trying to get very PC [politically correct] these days. So it's not like you know, like they're definitely procedure, but then I think our book has a lot of "labs" for each section or, or every few sections. So they're trying to do a hands-on thing. There's a lot of practice and it's a lot of straightforward practice. Although I do think that there are more applications. I think there's a lot more application type problems than there used to be. (personal communication, November 2006)

This was paraphrased as “Teachers should make sure that students are able to solve ‘application problems.’”

When talking about the school district’s curriculum guide, she said:

> They're [the authors are] trying to do all the different pieces like – although I think that the curriculum guide especially on the assessments, *they don't do enough straightforward problems*. How do I – like you spend so much time on learning how to multiply and divide decimals – And it's truly what the heart of it is and you want to know if they're able to do that. And yet there's like two problems that are actually here's a multiplication problem and this is a division problem on the test. And to me that doesn't seem right. You know, like – and *there are a lot of word problems*. There are a lot of very difficult word problems in terms of the wording. (personal communication, November 2006)
This was paraphrased as “Teachers should make sure that students are able to solve ‘word problems.’”

It appeared that Amelia had negative feelings about the messages she interpreted about the types of questions she was supposed to ask her students. By saying that the inclusion of application problems in the textbook was because the authors were trying to be politically correct and that there were not enough straightforward questions on the school district’s assessments Amelia indicated that she did not believe that application problems and word problems were as important as straightforward questions.

Although Amelia did not seem to be enthusiastic about application problems or word problems, Amelia’s classroom practices included these. For example, every lesson began with a warm-up consisting of three questions similar to those found on the school district’s and state’s assessments. Each day at least one of these questions was a word problem that required students to apply their mathematical knowledge to a situation in which a mathematical solution strategy was not obvious. Additionally, several of the questions she assigned to her students for homework were word problems requiring students to apply their knowledge to a context. Her inclusion of these types of questions may have been because Amelia felt obligated to prepare her students to do well on the school district’s and state’s assessments and these assessments asked similar types of questions.

Source of solution methods
One of the most contentious issues in modern mathematics education involves the question of how students should become acquainted with solution methods. Some argue that “students learn by creating mathematics through their own investigations of problematic situations, and that teachers should set up situations and then step aside
so that students can learn” (NRC, 2001, p. xiv). Others claim that “students learn by absorbing clearly presented ideas and remembering them, and that teachers should offer careful explanations followed by organized opportunities for students to connect, rehearse, and review what they have learned” (NRC, 2001, p. xiv). Of course, others argue for a teaching approach that is between these two extremes. Yet others contend that these views should not be thought of as opposite ends of a single dimension, but rather as separate dimensions of teaching (Stecher et al., 2006). Nevertheless, these two ways of acquainting students with solution methods have historically been seen as opposites.

Different terms have been used in conjunction with each of these ways of acquainting students with solution methods and each of these terms has been defined somewhat differently and is often used differently by different people. Some of the terms used for the first approach described above include discovery learning, inquiry, student centered teaching, reform teaching, and problem-based teaching. The terms direct instruction, teaching by telling, guided instruction, teacher centered teaching, and traditional teaching are frequently used to describe the second approach described above.

In her interview, Amelia interpreted there to be a message about the source of solution methods in the school district’s materials. When asked how she imagined the authors of the school district’s materials would want her to teach, she said:

The curriculum guide tries to be creative. So if you're able to do some of the activities and things that it suggests then you may have that opportunity to do things. . . . if somebody were to come in from the [central office of the school district] and see something I don't think that they would disagree, ‘cause I think you're always like focused toward – you know, if you're dividing decimals and you have a different way of doing it then I don't think anyone's going to argue that, you know what I mean? . . . I don't know, because I think the – you can actually – I think it would be encouraged to show something in more than one way as long as
it is age appropriate and grade level appropriate. (personal communication, November 2006)

Although at first glance it seemed that Amelia thought that the school district was open to a variety of ways of teaching, when this quote was looked at in the context of the rest of the interview it seemed that she meant something slightly different; she meant that the school district was open to having the teacher present a variety of procedures or solution methods. She did not interpret the school district to be promoting student development of a variety of solution methods. Amelia’s statements here were paraphrased as “Teachers should provide students with methods and worked examples to follow.”

This message seemed to be aligned with Amelia’s beliefs. On the beliefs survey she had an average score between not sure and agree on the statement: “Students learn mathematics best by paying attention when their teacher demonstrates what to do, by asking questions if they do not understand, and then by practicing.” Furthermore, Amelia did not indicate that she disagreed with this message. Additionally, she believed that she herself learns best in this way. In an interview, Amelia was asked about the most effective way for her to learn mathematics. As part of her answer, Amelia said, “I just watch and try and soak it in. . . more of the traditional way, I guess, is my comfort zone” (Amelia’s interview with Badertscher, July 2006).

Amelia’s classroom practices also reflected this message. When she talked about her teaching, she frequently used the words “show,” “explain” and “present” to describe what she did with her students. In the observed lessons, every new mathematical idea and solution method was presented by Amelia rather than developed by her students. For example, she showed her students how to solve division by decimals questions by moving the decimal point in the divisor and
dividend and then had her students practice the algorithm for homework. The next day she modelled decimal division with base-ten blocks on the overhead projector and then had the students work in small groups to practice solving similar problems and make sure that they arrived at the same answer as they would with the paper-and-pencil algorithm.

It is likely that the authors of the school district’s curricular materials would disagree with Amelia’s interpretation of their materials. For the observed lesson on decimal division, the curriculum guide states:

> The purpose of these lessons is to use modelling and estimation to explore dividing decimals. Students use base-ten blocks to model decimal division in the 4-6A Dividing by Decimals Hands-On Lab. Then, students explore decimal division and use estimation skills to decide if their answer is reasonable in 4-6 Dividing by Decimals and 4-7 Zeros in the Quotient. . . (District-wide Curriculum Guide, 6th Grade Unit 2A, p. 15)

The use of the word *explore* indicates that the students should have a hand in developing methods to solve decimal division problems. However, the idea of having the students explore and develop their own solution methods is not as apparent in the textbook.

For example, in 4-6A Hands-On Lab on Dividing by Decimals (Collins et al., 2001, p. 156) students are supposed to use base-ten blocks to model dividing a decimal by a decimal. The Hands-On Lab directions tell students to use a 10-by-10 block to represent 1 and to follow the (very explicit) steps on the page. After students work through this example and a similar example also modelled in the text, they are to use base-ten blocks to find the answer to four similar division questions and then answer one division question without using models. Immediately following the Hands-On Lab on Dividing by Decimals is a lesson on the same topic (4-6). In it students are told “When dividing decimals by decimals, change the divisor to a whole number. To do this, multiply both the divisor and dividend by the same power of 10.
Then divide as with whole numbers” (p. 157). After this statement several worked examples are given. In the margin of the teacher’s edition is a Suggested Reteaching Activity. Teachers are told to:

*Illustrate* 2.5 ÷ 0.5 on the overhead projector using decimal models. Then multiply the divisor and the dividend by ten. *Show* 25 ÷ 5 with models. *Guide* students to conclude that multiplying the divisor and the dividend by a power of ten does not change the quotient [italics added]. (p. 158)

Words like *illustrate*, *show*, and *guide* provide evidence that Amelia’s interpretation of the school district’s curricular materials was reasonable. Although the school district seemed to be attempting to at least occasionally have students be the source of solution methods, the school district selected a textbook which undermined this by presenting methods and worked examples to follow.

With regard to messages about *Source of solution methods*, Amelia demonstrated both a sense of obligation to the messages and a sense of personal discretion. Because she stated that the frequent inclusion of manipulatives in the textbook’s lessons were a result of “political correctness” her use of manipulatives in instruction was likely to have been a result of a sense of obligation to the school district’s and textbook’s guides which consistently talk about the use of manipulatives. Her change in the ordering of the lessons, however, is evidence that she felt some professional discretion.

*Technology*

One of the most controversial topics in mathematics education concerns the role of technology in mathematics classrooms. Most often, at the middle school level, the technology in question is the handheld calculator. Since the early 1980s inexpensive handheld calculators have been widely available for use in classrooms, yet almost 30 years later there are still frequent debates about if and how calculators should be used in classrooms. At the extremes are those who feel that students should have unlimited
access to calculators and those who oppose the use of calculators in grade school mathematics classrooms entirely. Many in the middle feel that students should only use calculators after they have demonstrated mastery of the procedure for which they are using the calculator.

Those opposed to unlimited access to calculators fear that extensive use of calculators interferes with students’ mastery of computational skills. However, “a large number of empirical studies of calculator use, including long term studies, have generally shown that the use of calculators does not threaten the development of basic skills and that it can enhance conceptual understanding, strategic competence, and disposition toward mathematics” (NRC, 2001, p. 354).

Although there is research based support for the use of calculators there are also philosophical issues to consider. The use of technology can change what mathematics is taught. Technology can amplify, that is, extend the existing curriculum by increasing “the number and range of examples with which students can come in contact” (Heid, 1997, p. 7) or it can reorganize the curriculum by causing one to question what knowledge of mathematics is necessary. It can change how it is taught by allowing the exploration of messy data sets and allowing students to focus on reasoning and conceptualization rather than computation. But, it can also obscure mathematical ideas. Thus there is not a clear, universally accepted answer to the question, “How should calculators and other technology be used by students?”

In her interview, Amelia brought up interpretations of messages about technology use twice. The first time was in discussion of Mathematics: Applications and Connections Course 1 (Collins et al., 2001):

Everyone's trying to get very PC [politically correct] these days…. now everyone's trying to incorporate technology in some way, shape or form or manipulatives in some way, shape or form you know…. So it's a little overboard sometimes…. (personal communication, November 2006)
This was paraphrased as “Teachers should incorporate technology in lessons.”

The second time that Amelia brought up a message about technology use was in discussion of the school district’s documents. She said that the textbook and school district’s curriculum guide were very similar and that the guide also tried “to incorporate technology” (personal communication, November 2006). This was also paraphrased as “Teachers should incorporate technology in lessons.”

It seemed that Amelia did not agree with the messages she heard about technology usage. In her interview, Amelia indicated that the incorporation of technology was a result of “political correctness” gone astray rather than a well-reasoned pedagogical move. Amelia limited her students’ access to technology because she was afraid that if her students had unlimited access to calculators, they would not learn how to compute by hand and she believed that it was important that they could do so. Additionally, she felt that all of her students should learn how to compute without a calculator even if they were allowed to use a calculator at all times because of a documented special need. In determining her practices, Amelia seemed to be using her professional discretion by following her beliefs about technology usage rather than following the messages that she heard.

It is interesting that Amelia interpreted the authors of Mathematics: Applications and Connections Course 1 (Collins et al., 2001) to be promoting the use of technology. In the introductory pages of this textbook, the use of technology is seemingly promoted. For example, the introductory letter to students, teachers, and parents states that students will “have opportunities to use technology tools such as the internet, CD-ROM, graphing calculators, and computer applications like spreadsheets” (Collins et al., 2001, p.iii). Additionally, the inside cover of that text lists nine “Features and Benefits” of the textbook. Technology is listed as one of these
nine, stating that the “Technology strand prepares students to function in a technological society through a variety of instruction and activities, including Technology Labs.” However, despite these promises, the role of technology is not always clearly promoted in the text of the book.

The Course 1 textbook contains six Technology Labs. Four of these labs focus on the use of spreadsheets and the remaining two focus on the use of graphing calculators. The use of calculators or computers in most of the other 137 lessons in the textbook is neither explicitly encouraged nor discouraged. Even when a question mentions technology it is not clear if students are to use technology to answer the question. For example, one of the exercises in the section on dividing decimals by whole numbers states: “The spreadsheet shows the unit price for a jar of jelly. To find the unit price, divide the cost of the item by its size. Find the unit price for the next three items. Round to the nearest cent” (Collins et al., 2001, Question 31, p. 154). Next to this exercise is a table listing the cost and size of various food packages. Even if students are encouraged or allowed to use a spreadsheet to answer this question, considering the amount of time it would take to set up a spreadsheet, this method of solution may not be the most appropriate.

Similarly, it is unclear that the authors of the school district’s materials promote the use of technology as strongly as Amelia interpreted. In the district’s mathematics curriculum guides, one of the four “Overarching Enduring Understandings” that the school district has chosen is that “Technology influences the mathematics that is taught and essential for our world” (School district’s Mathematics Instructional Guide, 2003, p. 3). By including this, the district has placed technology in a potentially prominent position. But, although the school district clearly allows the use of calculators in mathematics classrooms, it is primarily left to individual teachers
to determine when and how they will be used. For example, in the 6th grade mathematics course there is a 13 week unit on decimals, fractions, and percents. The school district’s curriculum guide devotes 172 pages to this unit. Only one lesson in this unit mentions the use of calculators by students. The only other times that calculators are mentioned in this unit are on the district-wide assessments where it is specified whether a calculator may or may not be used to answer particular questions.

When mathematics teachers in this school district are observed teaching, administrators consult a list of instructional practices which are considered to be consistent with the district-wide curriculum guide. Administrators are supposed to note if students “use calculators to develop and enhance conceptual understanding and as a tool in problem solving” and if “appropriate mathematical tools and models [are] accessible to students.” It is left to teachers and administrators to determine the meaning of appropriate.

Amelia interpreted the ambiguity in the messages about technology use as promotion of the widespread use of calculators. She, however, did not believe that students should use them very often and her practices were more reflective of her beliefs than the messages she interpreted. Perhaps she felt free to follow her own beliefs with regard to the use of technology because the messages were vague yet controversial.

Summary and comparison of findings with previous research
In summary, when Amelia and the other four teachers were in agreement with their interpretations of the messages, they usually followed through with these messages in their practices. Occasionally, despite their agreement with the messages, their practices were not reflective of the messages. It seemed that this was because the resources did not provide enough support to the teachers. When the teachers
disagreed with the messages, their practices were sometimes reflective of these messages. At times it seemed that this was because the teachers felt obligated to enact these messages. This sense of obligation was most apparent when there was a clear and consistent message both within and across resources. Lastly, when teachers disagreed with the messages, sometimes their practices did not reflect these messages. Teachers felt that they could use their discretion and ignore some messages. They seemed to feel free to ignore vague, inconsistent, or controversial messages.

These findings contrast with the findings of some previous studies. The majority of studies of educators’ interpretations of advisory messages have found that teachers tend to focus primarily on messages with which they agree and which are already reflected in their classroom practices (e.g., Berk, 2004; Hill, 2001; Spillane & Callahan, 2000). In this study, the teachers interpreted messages with which they agreed and which were reflected in their practices only slightly more than half of the time. Similarly, previous studies have found that teachers tend not to see conflicts between messages (Hill, 2001; Spillane & Callahan, 2000), but the teachers in this study saw many competing and conflicting messages both within and among the resources.

The fact that these teachers were enrolled in a master’s degree program which encouraged teachers to critically examine curricular resources may have contributed to the variety of interpreted messages. In fact, several of the teachers stated that their experiences in the master’s degree program changed how they viewed the resources. Alternatively, this difference may be because this study asked the teachers to interpret messages from a variety of resources while most other studies focused on only a single resource. The comparison of resources may have stimulated the teachers to talk about competing and contrasting messages.
Additionally, many studies have found that teachers often “traditionalize” reform-oriented curricular materials (e.g., D. K. Cohen, 1990; Hiebert & Stigler, 2000; Tarr et al., 2006). In contrast, some of the teachers in this study seemed to be attempting to “reform-ize” somewhat traditional materials. The teachers held primarily reform-oriented beliefs, but they interpreted many nonreform-oriented messages in the materials. Four of the five teachers seemed to be attempting to teach in primarily reform-oriented ways and the fifth teacher, Amelia, seemed to be attempting to integrate certain aspects of reform into her teaching.

Spillane et al. (2002) attributed the “limited” implementation of policy messages to teachers’ misunderstandings of the messages. They argued that the primary problem in the implementation of policy messages is that implementing agents understand them differently than policymakers intend. The teachers in this study, however, usually seemed to have reasonable interpretations of the messages.

Others have attributed the limited implementation of reform-oriented messages to teachers’ rejection of these messages. Most of the teachers in this study did not reject the reform-oriented messages; in fact, they embraced them. But, despite faithful efforts, they were not always able to follow through with these messages in their practices. It seemed that the degree to which the teachers were successful in reflecting reform-oriented messages in their practices was closely related to the degree to which the materials provided actual (as opposed to superficial) support for these messages. In contrast, the teachers did seem to be rejecting most of the nonreform-oriented messages. Their practices, however, frequently reflected these messages because there was so much support for these messages in the materials. This was especially apparent in the Question types and Source of solution methods themes in this study.
Surprisingly, the teachers in this study did not talk much about the effects of standardized testing on their teaching. It is likely, however, that, like the teachers in Tomayko’s (2007) study, the teachers in this study would say that the pressures they feel from high-stakes testing influence what and how they teach. Specifically, although the teachers were not always enthusiastic about it, the teachers were observed assigning questions similar in content and format to those found on the school district’s and state’s assessments. As has been documented in other studies (Chazan & Schnepp, 2002), the teachers seem to have accepted that high-stakes tests are a part of today’s schools and thus have changed their practices to reflect these assessments.

**Implications and discussion**
In some ways the tensions that the teachers felt as a result of the conflicting and/or competing messages seemed to be helpful; they helped the teachers clarify their own beliefs and commitments. Having a wide variety of messages from which to choose allowed them to feel that no matter what they choose to do, they had at least nominal backing. But, because it is impossible to follow all of these messages, when teachers felt a sense of obligation to the messages, they were in an impossible situation. To help teachers, the entire mathematics education community (including curriculum writers, policy writers, school district officials, teacher educators, and professional developers) needs to become more conscious of the messages put forth in curricular resources.

First, educators need to consider the consistency of our messages. We should ask ourselves, “Are the messages within this resource consistent and how do these messages fit with the messages in other resources?” This is especially important for school district officials. Although it is unlikely that there will ever be complete
curricular coherence (especially across all aspects of mathematics education) and it is at times politically challenging to achieve consensus, school district officials have an obligation to send coherent messages through the resources they select. When inconsistent messages are present, it is very difficult for teachers to follow through with these messages in their practices.

Second, we need to be more specific about our intentions. Phrases such as “emphasize concepts and procedures,” “have students solve application problems,” “have students discover,” and “use technology appropriately” can be interpreted in a wide variety of ways. Curriculum writers, policy writers, and school district officials especially need to clarify what they mean by these and other word choices. When messages are vague, many interpretations are possible and teachers do not feel obligated to follow them.

Third, we need to provide support to teachers. This is especially important when reform-oriented messages are being put forth. For example, in addition to telling teachers to teach through problem solving, materials need to illustrate for teachers what this might look like and provide true problems (rather than only computational practice questions) for teachers to assign to students. When supports are lacking, teachers have difficulty following through with messages – even if they agree with them.

Lastly, teacher educators and professional developers must help teachers learn to critically examine curricular resources in order to become more aware of the messages contained in them. Both pre-service and in-service teachers should be asked to compare and contrast the messages they see both within resources and among resources and to compare these messages to their own beliefs and to what is known about effective mathematics education. By doing so, teacher educators and
professional developers can help teachers become more conscious of their decisions regarding to which messages they will attend and which they will try to ignore.

Hopefully this study has shed some light on the messages which teachers interpret from curricular resources and why teachers feel obligated to follow certain messages, yet feel they may ignore other messages. Further research with more teachers will help us learn more about how to best support teachers in their efforts to reform their teaching.

References


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Make sense? Completing extracurricular activities means you are going above and beyond your school requirements. However, simply playing soccer with your friends on the weekends for fun isn’t actually an extracurricular activity, even though it has nothing to do with school. For example, let’s say you’re really good at maths and your teacher encourages you to get involved in competitions. You join the school team and start training for the national Maths Olympiad. During the process you realise how fun maths can be and how talented you actually are, which gives your confidence a massive boost. This is exactly what happened to Australian student, Seyoon Ragavan now he’s studying maths at Princeton University in the US!