

Paper Discussion: **Issues in Mathematics Education**

## **A Cross-Site Study of Local Factors Affecting Mathematics Curriculum Enactment**

Presented by

Kathryn B. Chval, University of Missouri  
Douglas A. Grouws, University of Missouri  
Mellisa Smith, Horizon Research, Inc  
Steven Ziebarth, Western Michigan University



## **Background and Purpose of the Cross-Site Study**

This paper is the result of a cross-site study conducted under the auspices of the National Science Foundation funded Center for the Study of Mathematics Curriculum (CSMC) to explore curriculum enactment of a particular mathematical topic in three school districts. CSMC is a collaborative partnership involving the University of Missouri, Michigan State University, Western Michigan University, the University of Chicago, Horizon Research, Inc., and three school districts.

The perspective underlying the study was that there are a number of reasons why teaching and learning of a particular mathematical idea might not be optimal. For example, teachers may lack knowledge of the content, or they may not agree with the philosophy of the textbook they have been assigned, or they may not have the resources or pedagogical skills to implement the associated instructional activities well. Knowing the status of the enacted curriculum is necessary but not sufficient for deciding what needs to be done to improve the curriculum and the teaching of it. Accordingly, the study collected data to help explain both the “what” and the “why” of the enacted curriculum so that district leaders would be able to develop plans for improving teaching and learning.

After a decision was made to explore the curriculum enactment for a specific mathematical topic, district representatives selected “composing and decomposing” as the focus of the study. All involved agreed that this was an area of mathematics that teachers find challenging to teach and that students find challenging to learn. Nevertheless, the hope was that the study would both inform the participating districts, and provide a model for others in the field to use in studying the implementation of particular mathematical ideas of interest.

The research plan was to develop a teacher survey that would act as an initial diagnostic tool, providing a district with a broad sense of the district’s status in each of the following areas:

- Teacher attitudes and beliefs about mathematics and mathematics teaching;
- Teacher perceptions of their preparedness in mathematics content, and in using particular pedagogical strategies; and
- Classroom practices, including those related to composing and decomposing.

Two versions of the teacher survey were developed—for teachers in grades K–5 and 6–12; and a survey was administered to the population of teachers of mathematics in each of the three districts during the months of February and March 2005. Teachers responded anonymously and the response rates in the three districts ranged from 74 to 79 percent. This paper provides a summary of some of the data from that study, focusing mainly on local factors that can affect the enactment of curricula.

## **Overview of the Teacher Surveys**

The first two sections of each of the teacher surveys collected general information about teachers’ backgrounds and their practices in a “target” mathematics class. Many of the items in these two sections were drawn from earlier surveys including the 2000 National Survey of

Science and Mathematics Education Mathematics Teacher Survey (Weiss, Banilower, McMahon, & Smith, 2001), and an instrument developed by Ross and colleagues (2003). Section A of the survey examined teachers' attitudes and beliefs about mathematics and mathematics teaching, as well as their knowledge of preparedness in mathematics content. Section B asked teachers to describe their use of particular pedagogical strategies for a specific mathematics class, and to provide their opinions about the instructional materials used for that class. The final section (Section C) asked about instructional practices through a content lens. In exploring content related to "composing and decomposing," survey designers selected topics such as addition, subtraction, and number sense for the elementary survey; at the secondary level, the topics included mathematics sense making, factors and multiples, and rate of change. For each of the content topics, a series of sub-items posed a variety of ways in which that particular content might be taught. The sub-items are not intended to reflect a particular curriculum, but rather to give teachers a wide range of choices of activities that are reflected in numerous curricula. The sub-item choices represent the best effort of the survey designers to not only attend to the range of common activities/approaches associated with each mathematical topic, but to recognize that teachers may use other ways to engage their students. Specific attention was given to including activities that would distinguish tendencies between traditional approaches and more exploratory/alternative approaches used in the teaching of specific topics during whole class instruction.

Each sub-item asked teachers to consider whole group instruction for the particular topic and estimate the *percentage of time* spent on each of the sample activities. Response choices were "more than 25%" of the time, "11–25%," "1–10%," and "None." The summary tables that follow collapse the latter two categories for each district.

## **Selected Results from the Study**

In analyzing the data, we noticed that there were several local factors that have the potential for affecting the manner in which school curricula were enacted.

### ***Characteristics of the Teaching Population***

In Section A of the survey, teachers were asked to provide information on their teaching background and experience. Table 1 shows that in two of the districts (Districts A and B) approximately 30 percent of the teachers have 5 or less years of experience teaching mathematics. Results such as these might suggest that a district pay particular attention to the support (induction/mentoring/professional development programs) needed by its novice teaching force who undoubtedly have to contend with many issues including the implementation of new instructional materials.

**Table 1**  
**Teachers' Experience Teaching Mathematics, by Grade Range and District**

	Percent of Teachers					
	Grades K-5			Grades 6-12		
	District A	District B	District C	District A	District B	District C
<b>Years taught mathematics</b>						
1-5 years	31	29	20	35	36	20
6-10 years	21	23	24	14	24	30
11-15 years	18	11	17	18	12	13
16-20 years	14	5	12	7	8	13
21-25 years	10	9	8	12	0	8
26 or more years	6	24	21	14	20	18

***Characteristics of the Mathematics Classroom***

Although the typical elementary teacher teaches mathematics to a single group of students, many secondary mathematics teachers teach multiple classes. To reduce the burden on teachers assigned to teach multiple sections of mathematics, each teacher was asked to respond to a series of items about a single “target class,” their first class of the day. Teachers were asked to report on such characteristics as the number of students in their target class, the percentage of students requiring special education services, as well as how instruction time was distributed across a variety of teaching procedures and activities.

Table 2 provides information on the structure of a typical mathematics lesson in each district. At the elementary level, the three districts are fairly similar in the way they distribute time among whole class, individual, and small group activities, although District A’s elementary students spend more time in small group activities and less time in whole class lecture/discussion than do students in the other districts. At the secondary level, the three districts distribute their time quite differently. District A classrooms tend to emphasize small group work, and District B classrooms emphasize whole class lecture/discussion.

**Table 2**  
**Time Spent in “Target” Mathematics Class, by Grade Range and District**

	Percent of Targeted Classes					
	Grades K–5			Grades 6–12		
	District A	District B	District C	District A	District B	District C
<b>Percent on daily routines, interruptions, and other non-instructional activities</b>						
10 percent or less	78	66	50	79	59	44
11–20 percent	15	18	29	19	37	40
21–30 percent	4	13	12	2	4	9
31 percent or more	3	3	8	0	0	7
<b>Percent on whole class lecture/ discussion</b>						
10 percent or less	9	15	12	12	7	0
11–20 percent	39	29	25	19	4	28
21–30 percent	31	16	23	33	22	37
31 percent or more	21	40	40	35	67	35
<b>Percent on individual student work (e.g., reading textbooks, completing worksheets)</b>						
10 percent or less	42	31	29	56	4	12
11–20 percent	26	26	26	24	37	36
21–30 percent	19	24	28	7	26	33
31 percent or more	13	19	18	13	33	19
<b>Percent on small group work</b>						
10 percent or less	3	21	9	9	30	14
11–20 percent	12	21	20	11	33	23
21–30 percent	19	19	23	11	22	26
31 percent or more	66	40	47	70	15	37

For any district it is important to ensure that the distribution of time spent among these activities is aligned with what is intended in the curriculum program used in that district.

***Teachers’ Use of Instructional Materials***

Teachers were asked to respond to several items regarding their use of instructional materials in the target class. Table 3 provides information on teachers’ ratings of the quality of the mathematics textbooks/programs used for the target mathematics class. In each grade range, the distribution of ratings in District A is significantly different from that in Districts B and C, with District A’s ratings tending to cluster more at the high end of the scale.

**Table 3**  
**Teachers' Ratings of the Quality of the Designated Mathematics Textbook/Program,**  
**by Grade Range and District**

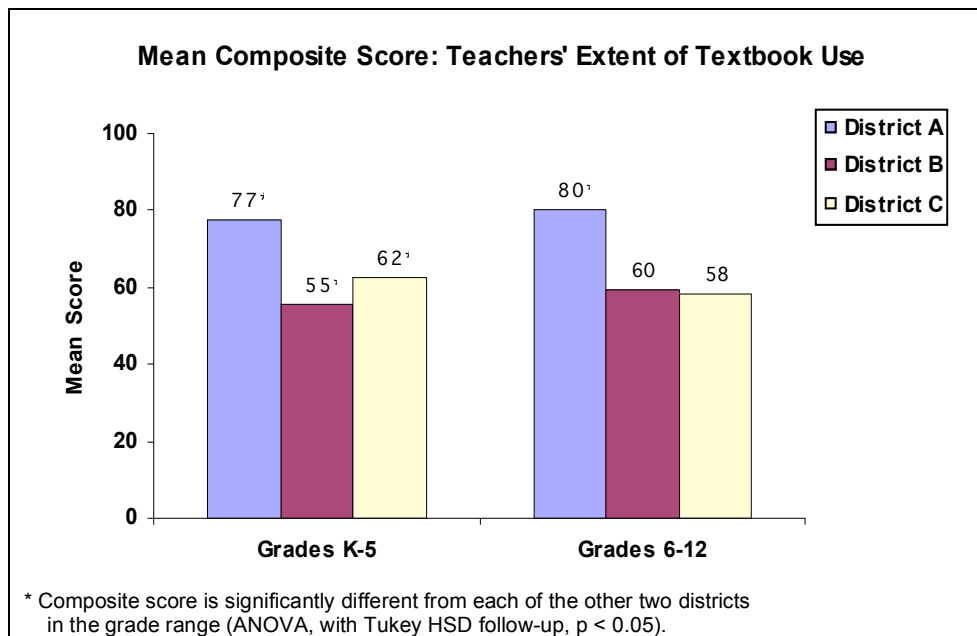
	Percent of Teachers					
	Grades K-5			Grades 6-12		
	District A*	District B	District C	District A*	District B	District C
Very Poor	1	10	9	0	0	2
Poor	4	10	9	2	8	14
Fair	7	25	23	4	20	21
Good	34	19	33	21	44	33
Very Good	39	29	18	40	20	28
Excellent	15	6	9	33	8	2

\* Distribution of teacher ratings in District A is significantly different from each of the other two districts (Kruskal-Wallis, with z-test follow-up,  $p < 0.05$ ).

The results for Districts B and C suggest that they may want to further investigate the reasons behind their teachers' low ratings of the quality of the designated instructional materials. If teachers do not perceive their materials as being of high quality, then there is little chance that curriculum enactment will be effective.

To facilitate the reporting of the large amounts of survey data collected, and because individual survey items are potentially unreliable, analysts combined groups of conceptually related survey questions into "composites." Each composite represents an important construct related to mathematics teaching. Items, related to the nature and extent of textbook use, were combined into an *extent of textbook use* composite. Examples of items in this composite are the percentage of instructional time based on the textbook, the percentage of the textbook covered during a school year, and how often the teacher uses the teacher guide to plan lessons

As can be seen in Figure 1, at each grade range teachers in District A had higher composite scores (i.e., tended to use their textbooks more extensively) than did teachers in the other two districts. This finding is not surprising given District A teachers' higher ratings of the quality of their textbooks.

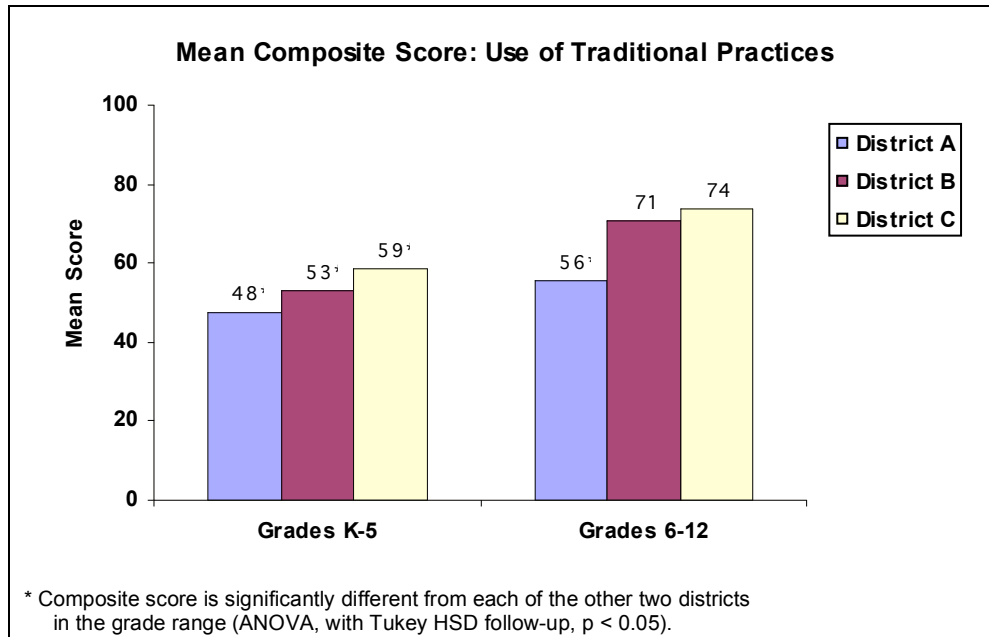


*Figure 1*

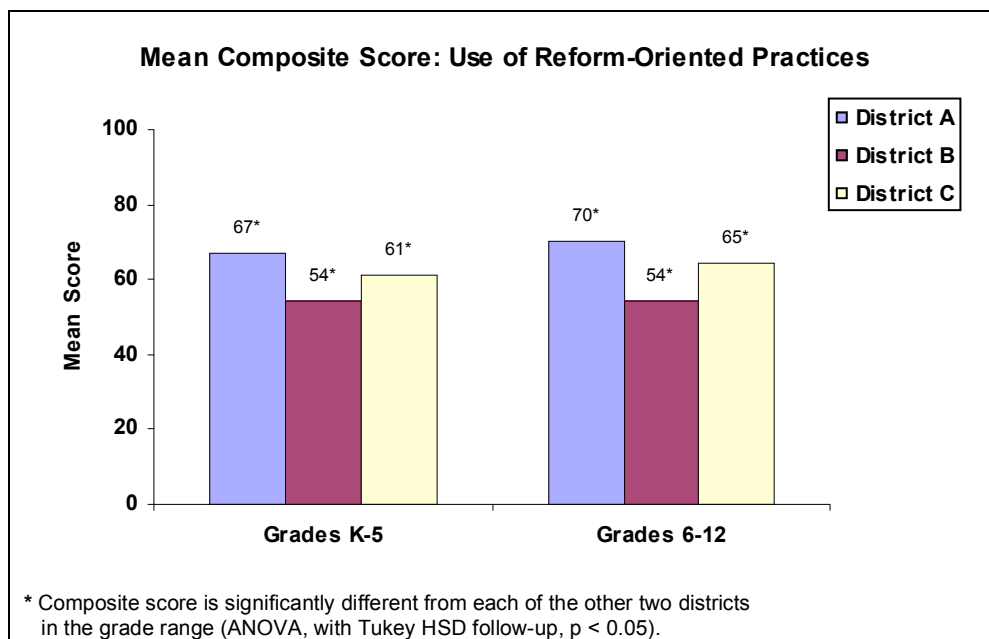
### *Teachers' Instructional Practices*

Two composite variables were created to describe teachers' classroom practices. The *use of traditional teaching practices* composite is comprised of four items – the frequency with which teachers introduce content through formal presentations, pose close-ended questions, have students listen and take notes during a teacher-led presentation, and have students practice routine computations/algorithms. The *use of reform-oriented teaching practices* composite is comprised of eleven items such as the frequency with which teachers encourage students to explore alternative methods for solutions, encourage students to use multiple representations, and have students work in small groups.

Elementary teachers in District A report using reform-oriented instructional practices more and traditional practices less than do teachers in Districts B and C (see Figures 2 and 3.) Results are similar at the secondary level. These data are consistent with the data on the structure of mathematics lessons, where teachers in District A devoted more time to small group activities than to individual student work and teachers in District B devoted more time to whole class lectures/discussions than to small group activities. These data allow district leaders to compare actual teaching practices with those intended by a particular set of instructional materials.



*Figure 2*



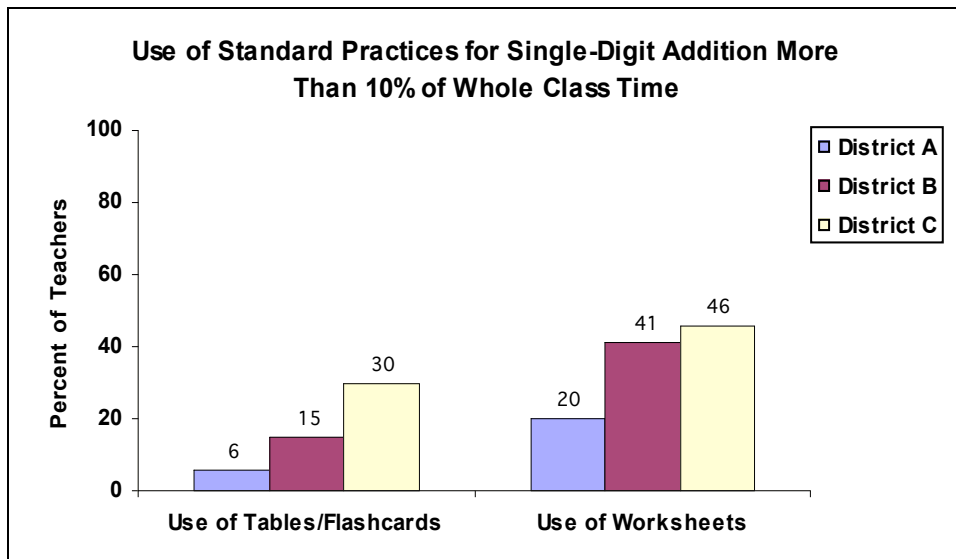
*Figure 3*

***Instructional Practices around Composing and Decomposing at the K-5 level***

For the content-specific section of the elementary teacher survey, five mathematical topics relating to “composing and decomposing” were identified. The content item groupings were: single-digit addition, two-digit addition, three-digit addition, subtraction, and number sense. In this paper, we highlight two of the content items.

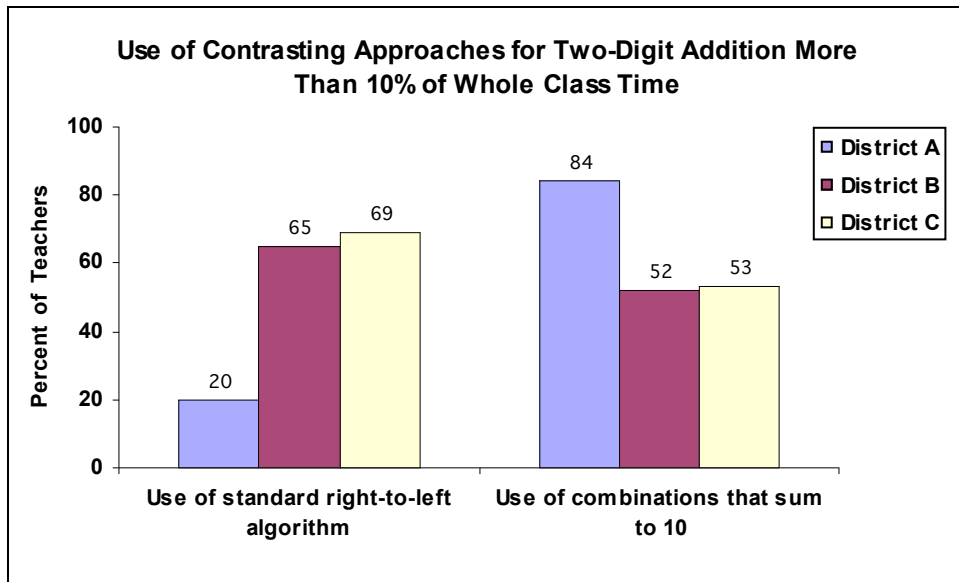
For single-digit addition, teachers were asked to report the percentage of time spent on each of five activities related to whole-group instruction of this concept. The clearest differences amongst the districts in their approaches to teaching single-digit addition involved the more traditional practices (i.e., using tables/flashcards and practicing sums using worksheets). For example, only 6 percent of District A’s teachers report using tables/flashcards more than 10 percent of whole class instructional time, compared to 15 percent in District B and 30 percent in District C (see Figure 4).

Similarly, 20 percent of the teachers in District A report using practice worksheets fairly often (more than 10 percent of whole class time) as compared to 41 percent and 46 percent in Districts B and C, respectively.



*Figure 4*

With regard to two-digit addition, teachers were asked again to report on five activities related to this topic. Figure 5 highlights the extent to which teachers from District A reported spending time on alternative computation strategies for addition with two-digit numbers. Eighty-four percent of District A's teachers indicated they spent more than 10 percent of the time on finding combinations that add to 10, as compared to 52 percent in District B and 53 percent in District C. Furthermore, more teachers in Districts B and C reported that they spent more time using the standard algorithm. Even though all three districts are working to enact mathematical teaching practices that emphasize alternative strategies and reduce the emphasis placed on traditional practices, teacher reports demonstrate that District A appears to be making more progress than the other two districts in this regard.



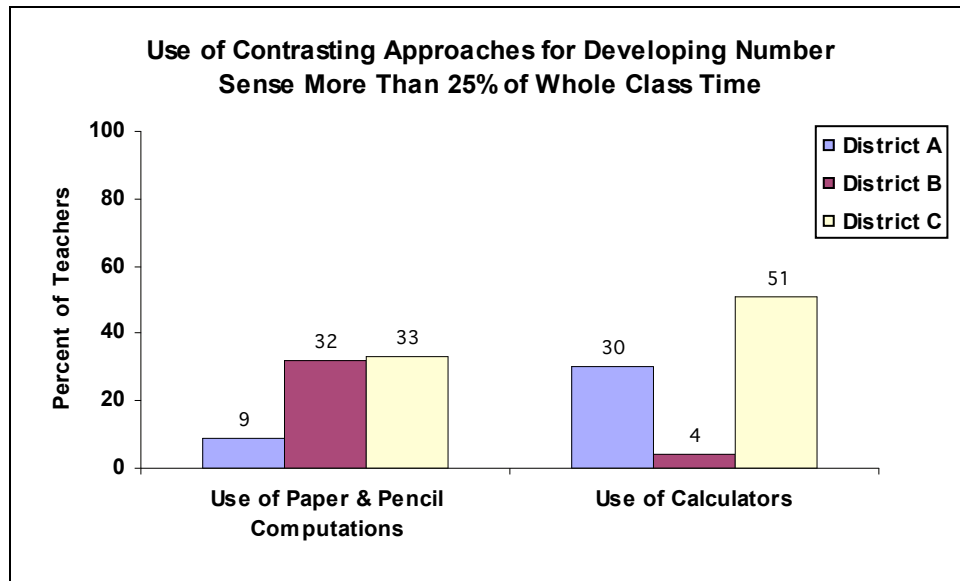
*Figure 5*

***Instructional Practices around Composing and Decomposing at the 6-12 level***

For the content-specific section of the secondary teacher survey, eight mathematical topics were identified that related to “composing and decomposing.” The content item groupings consisted of: number sense, mathematics sense-making, equivalent fractions, factors and multiples, the distributive property, linear functions, areas of polygons, and rate of change. Again, we focus on two of the eight content items.

With regard to teaching number sense, perhaps the clearest difference in the districts’ approaches is practicing paper and pencil computations. Only 9 percent of 6–12 teachers in District A report using this activity more than 25 percent of whole class instructional time compared to roughly 33 percent of secondary teachers in Districts B and C (see Figure 6).

As for using calculators in developing students’ number sense, 6–12 teachers in District B responded quite differently from the other two districts. Almost one-third of the District A teachers and roughly one-half of District C teachers use calculators more than 25 percent of the time in whole class instruction to teach number sense, compared to only 4 percent of those in District B.



***Figure 6***

With respect to teaching linear functions, Figure 7 highlights the variability among the three districts in emphasis placed on two common approaches. In light of understanding curricula enactment, it would be interesting to see how closely related the emphasis on these approaches is to the districts' instructional programs. It is not clear the extent to which these differences are reflections of curriculum emphases and/or teacher preferences.

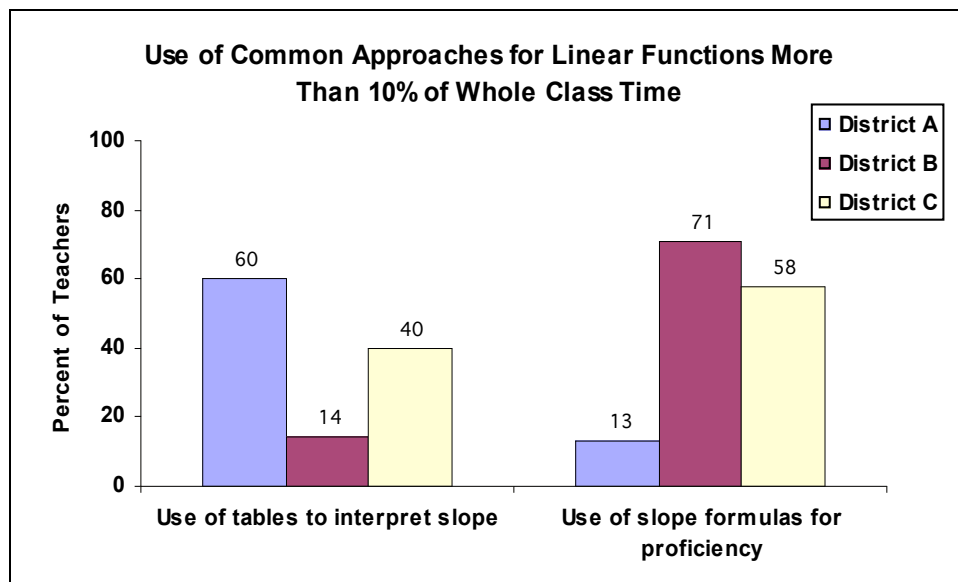


Figure 7

## Summary, Implications, and Limitations

The way a curriculum is implemented affects students' opportunity to learn mathematics, yet classrooms in which the same reform curriculum and teaching practices are purportedly being used may be quite different from one another (Kilpatrick, 2003; Lambdin & Preston, 1995; Spillane & Zeuli, 1999). The cross-site survey results reported here indicate that elementary and secondary teachers across the three districts are using their mathematics curricula quite differently, and that teachers within the same district are using their curricula quite differently.

The use of composites helped to identify significant differences in teachers' actual classroom practices even though there were some similarities across districts and grade bands on particular items and there were no significant differences among districts at either grade band in relation to teacher *beliefs* about reform-oriented practices. An examination of these composites shows that District A teachers, as compared to Districts B and C, reported that they spend a higher percentage of time using their mathematics textbooks, "cover" a higher percentage of their textbooks, and rate the quality of their textbooks higher. Furthermore, District A teachers report using reform-oriented instructional practices more and traditional practices less than teachers in the other two districts.

The overall results of the cross-site survey suggest that teacher surveys can be a useful tool in determining teacher perceptions related to curriculum enactment within a school district, as well

as how those perceptions compare with teachers from other districts. In particular, surveys can help identify (1) teacher beliefs about the quality of district-adopted textbooks, teacher preparedness, and professional development expectations and needs; and (2) the nature (i.e., type and frequency) of specific instructional practices. This identification in turn can assist district administrators and curriculum coordinators assess weaknesses in curriculum enactment and help with decisions regarding professional development or future textbook selection policies.

The survey results can help determine some overall trends in teacher beliefs and instructional practices across the district as reported by teachers; yet additional tools are needed to look more carefully at understanding curriculum enactment. For example, district personnel potentially may need to conduct classroom observations or teacher/administrator focus groups to examine more specific classroom practices, perceptions, or needs as well as help interpret or make decisions regarding data from the survey. In other words, the survey is a practical, cost-effective tool that captures a snapshot of curriculum enactment at the district level. This snapshot can then be used to guide district leaders as they determine how to more specifically look at curriculum enactment within their local contexts.

## References

- Kilpatrick, J. (2003). What works? In S. L. Senk & D. R. Thompson (Eds.), *Standards-based school mathematics curricula: What are they? What do students learn?* (pp. 471-488). Mahwah, NJ: Lawrence Erlbaum.
- Lambdin, D. V. & Preston, R. V. (1995). Caricatures in innovation: Teacher adaptation to an investigation-oriented middle school mathematics curriculum. *Journal of Teacher Education*, 46 (2), 130–140.
- Ross, J. A., McDougall, D., Hogaboam-Gray, A., & LeSage, A. (2003). A survey measuring elementary teachers' implementation of standards-based mathematics teaching. *Journal for Research in Mathematics Education*, 34, 344–363.
- Spillane, J. P. & Zeuli, J. S. (1999). Reform and Teaching: Exploring Patterns of Practice in the Context of National and State Mathematics Reforms. *Educational Evaluation and Policy Analysis*, 21(1), pp. 1–27.
- Weiss, I. R., Banilower, E. R., McMahon, K. C., & Smith, P. S. (2001). *Report of the 2000 national survey of science and mathematics education*. Chapel Hill, NC: Horizon Research, Inc.