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ABSTRACT

This study investigated the influence of textbooks on teaching strategies, specifically secondary school mathematics textbooks. The study compared the teaching strategies of 14 teachers using University of Chicago School Mathematics Project (UCSMP) textbooks in 13 schools with that of another 14 teachers using traditional textbooks in those schools. Data collection included classroom observation, teacher interviews, and teacher background questionnaires. The teacher interviews discussed: whether or not the class period observed was typical; teaching methods used by the teacher; and whether the UCSMP textbook required teachers to adapt their teaching style. Background questionnaires examined: teachers' level of education; teaching experience; subjects taught; certification; and opinions on different aspects of the course. Data analysis indicated there were important differences in teaching strategies between the two groups. Compared with teachers using non-UCSMP textbooks, teachers using UCSMP textbooks spent significantly more time on group work and on the reading of textbooks. They also devoted significantly less time to lecturing and to seatwork. Compared to teachers using non-UCSMP materials, there were significantly more teachers using UCSMP textbooks who employed technology, including computers and calculators, in their teaching strategies. Differences in teaching strategies were closely related to, and consistent with special features of UCSMP textbooks compared with the other textbooks. Teachers using UCSMP textbooks perceived that the textbooks had important influences on their teaching strategies. (Contains 5 tables and 18 references.) (SM)

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Textbooks Use and Teaching Strategies: An Empirical Study

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ABSTRACT. This study investigates the influence of textbooks on teaching strategies. Teaching strategies of 14 teachers using University of Chicago School Mathematics Project (UCSMP) secondary textbooks in 13 schools were compared to that of another 14 teachers using other textbooks in those schools. By analyzing the data collected from classroom observations, teacher interviews and questionnaires, the authors found that teachers using UCSMP textbooks devoted significantly more time to "group work" and less time to "lecture demonstration" in their instruction. They also allocated considerably more time to "reading textbooks" and less time to "seatwork", and used more technology (calculators and computers). Those differences were closely associated with the features of the UCSMP textbooks. The authors conclude that textbooks do affect teaching strategies by conveying pedagogical orientation to teachers and providing them with certain encouraging or discouraging curricular environment for employing different teaching strategies, and hence their role in teachers' teaching practices should be adequately recognized by textbook authors, curriculum reformers and designers, as well as school teachers and administrators.

Introduction

Over the last ten years, educational researchers have continuously pointed out the lack of research centering on textbooks and their role in teaching practice, and called for more studies in this area. For example, in the early 1980s, McCutcheon (1982) argued that little had been known about the nature, character, and qualities of teachers' and students' use of textbooks (also see Graybeal, 1988, p.124). In the mid 1980s, Graybeal and Stodolsky (1986) reported that "the analysis of curriculum materials seems to be a relatively unexplored field of study". Later, in a review of the research literature on this topic, Stodolsky (1989) again emphasized that "exactly what the presence of textbooks signals about their use has not been adequately studied or analyzed"; in the same year, Freeman and Porter (1989) argued that even though textbooks played a central role in most classrooms, surprisingly little research has focused on teachers' use of textbooks . Recently, Sosniak and Stodolsky (1993) claimed that "systematic attention to textbooks and their use by teachers and students is long overdue".

In this study, we intend to investigate, and hence shed some light on, one issue in this field, namely, for mathematics teaching at the secondary school level, how do textbooks

affect teachers' teaching practices in math classrooms? Specifically, through comparing the teaching practices of teachers using math textbooks developed by the University of Chicago School Mathematics Project (UCSMP) and those using non-UCSMP textbooks, we would like to address the following questions:

1. Are there significant differences in the teaching strategies of teachers using UCSMP textbooks and those using non-UCSMP textbooks? Though "strategy" is a very commonly-used word, here by "teaching strategy" we mean the way a teacher performs his/her teaching task in the classroom. "Teaching method" and sometimes "teaching style" can have an equal or very close meaning to it. In other words, if "teaching content" means *what* the teacher teaches in the classroom, then by "teaching strategy" we mean *how* the teacher teaches. They are two distinctive but related aspects of teaching.

2. If the answer to the above question is "yes", how is the difference of teaching strategies related to the textbooks used? Or, in other words, what do the distinctive features of UCSMP textbooks from other textbooks contribute to the different teaching strategies?

UCSMP has been one of the largest as well as most progressive projects on curriculum reform and development in the U. S. since its inception in 1983. It has developed a whole series of secondary mathematics textbooks with special features and substantial differences compared to most traditional teaching materials, including integrated use of technology, extensive opportunities for cooperative learning, and many readings in the textbooks (see more details later). This is the most important reason for us to choose UCSMP textbooks as the main object of comparison to other non-UCSMP ones in this study. In fact, as Usiskin (1985), its director, once said "we need another revolution in secondary school mathematics", UCSMP textbooks do in some sense reflect such an ideology.

Below this article is in four sections. Section 1 gives a brief review of recent relevant research in this field. Section 2 describes the methodological matters of this study. Section 3 explains the results, along with our analysis and discussion. The last section presents main conclusions and implications drawn from this study.

Related Research

First we examine recent relevant research on the role of textbooks on teachers' teaching practices in the subject of mathematics, which might to some extent be served as background for this study.

Floden, Porter, Schmidt, Freeman, and Schwille (1981), in their article, "Response to curriculum pressures: A policy-capturing study of teacher decision about content", present a study of 66 fourth-grade mathematics teachers to determine the relative power of six factors that might have influence on their decisions about the content taught in mathematics classrooms. These six factors are district tests, textbooks, district instructional objectives, other teachers' opinions, the principal's opinions, and parents' opinions. Based on teachers' responses to four decision-making questions about "adding core topics", "adding peripheral topics", "omitting core topics", and "omitting peripheral topics", they found that teachers perceived textbooks to be the least (or one of the least) powerful factor(s) that influenced their decisions on mathematics content to be taught in their classrooms.

In some sense, Schwille, Porter, Belli, Floden, Freeman, Knappen, Kuhs, & Schmidt (1983) research, which studied seven teachers of grades 3 to 5 in six schools in three districts about how they made content decision, extended Floden *et al.*'s work. Using case studies of these teachers, Schwille *et al.* revealed that different teachers did not teach the same content even when they were using the same textbooks. Teachers had a considerable discretion in the use of textbooks. Some of them followed the texts very closely, while others did that very selectively .

Krammer's (1985) study of the textbooks as classroom context variable involved the comparison of teachers' teaching practices of using three different textbooks. Using the data collected through the observation of classrooms and administration of tests and questionnaires to students and teachers from 50 eighth-grade mathematics classes in 17 schools preparing for colleges in Netherlands, he found that there was a significant overall difference in teaching practice between three textbook user groups. More precisely, four of

the nine teaching practices variables, namely, the frequency of higher-order questions, the amount of seatwork, the amount of academic conversation, and the students' perception of remedial help (the other five are structuring by the teacher, reference-to-book questions, brushing-up prerequisites, practical applications, and different activities), occurred to significantly different degrees. Overall, teachers using a textbook which included plenty of seatwork did much more often use "seatwork" activity in their classrooms, those using a textbook in which its authors avoided high-level questions did ask much less of such kind of questions than other teachers, and less academic conversation was consistently found in the classes using less academically demanding textbooks. However, according to Krammer, it is not clear whether the consistence of the teaching practices and the textbooks' features arose because the teachers followed the books or because they choose a textbook that resembled their preferred teaching style.

A similar study was conducted by Tomic (1983). Using the data collected from a questionnaire survey about the classroom behaviors to mathematics teachers, the study suggested that teachers using different textbooks applied different teaching practices, and with 62 teaching practice variables, 10 differed significantly between the users of different textbooks in terms of ANOVA analysis.

Based on an intensive study of classroom activity, which included the observation of 22 fifth-grade classrooms in 11 school districts in Chicago area for two consecutive weeks, Stodolsky (1988) described a general picture of how mathematics teachers used their textbooks. She claimed that everything in textbooks was not used by math teachers. They often omitted introductory examples or materials and assigned only some of the problems which did not include word problems and other application exercises contained in the books. They also made materials or used commercially available materials related to the topics under study. However, teachers usually did not introduce topics not included in the textbooks and change the sequences of chapters of the books (p.111).

Barr's (1988) study of conditions influencing content taught in nine fourth-grade mathematics classrooms in five schools from three districts which were also located in Chicago area presented a different story from that of Stodolsky's mentioned above. According to Barr, the nature of lessons and the problems contained in the mathematics textbooks determined what was taught; teachers rarely deviated from or supplemented textbook content. The number of lessons on a topic directly influenced the number taught, and the number of problems included in the textbook influenced the number assigned. Overall, there was a close relation between the emphasis a textbook gave to a topic and its development and practice in class. Most teachers did not sample work selectively, particularly in review area, but proceeded lesson by lesson through their textbooks.

By investigating four fourth-grade mathematics teachers' styles of textbook use and the match between content taught and textbook content in four elementary school classrooms for a school year-long time, Freeman and Porter (1989) challenged the popular notion that elementary school teachers' content decisions were dictated by the textbooks. Using daily teacher logs and a three-dimensional classifications as guides, they generated detailed classification of all content presented in the textbooks and that presented to students and found that teachers did not always defer to the authority of their textbooks and had considerable differences when deciding (a) what topics to teach, (b) how much time to spend on each topic, or (c) in which order topics are presented.

Sosniak and Stodolsky's (1993) year-long study of 4 fourth-grade teachers in 2 urban schools obtained conclusions which are largely consistent with Freeman and Porter's aforementioned findings. Using an ecologically based research approach with the data collected from classroom observations, semi-structured and tape-recorded interviews with teachers, and content analyses of the materials used in the four classrooms of three school subjects including mathematics, arts/reading, and social studies, they found that the influence of textbooks on classroom instruction and teachers' thinking was less than the literature would have people expect. Textbooks do not control the elementary curriculum to the extent

people often assumed, and textbooks content does not necessarily directly influence what students learn. Further, they deduced that textbooks themselves could not be assigned major responsibility for the variety of problems associated with elementary education.

In sum, we can note that, among the limited number of studies about the role of textbooks in teaching practices of mathematics subject reviewed above, 1. overall the majority have focused on how textbooks affected the content of teaching, and only a very few studies have dealt with how textbooks influenced strategies teachers used to teach; 2. there existed inconsistency between the conclusions of the reviewed studies. For such inconsistency, for example, as those of Barr's and Freeman and Porter's studies, one possible explanation might be that the researchers used different textbooks which might have affected teachers' using them differently. Namely, there might be different patterns for teachers to use different textbooks; 3. most of the prior studies were on elementary school mathematics, and only a very little was conducted on secondary; 4. the scale of most studies were rather small, implying as it can be easily understood that large scale study in this area is hard to be conducted.

Method

This study focuses on how textbooks affect teachers' "teaching strategies" in their classrooms. The data we used were obtained from four pilot studies of textbooks conducted at the University of Chicago. The studies were Transition Mathematics Second Edition Field Study, Algebra Second Edition Field Study, Geometry Second Edition Field Study and Advanced Algebra Second Edition Field Study. The first two studies were conducted in 1992/93 and the latter two in 1993/94. These studies were carefully designed by a group of professors in education and experts in evaluation to test a revised course in a variety of contexts including different regions of the country, different socioeconomic groups and different grade levels. They took the form of a matched pair design, with *Transition Mathematics* second edition classes matched to classes using traditional pre-algebra

textbooks, *Algebra* to traditional algebra 1 classes, *Geometry* to traditional geometry classes, and *Advanced Algebra* to traditional algebra 2 classes in the same schools.

Like many other studies conducted in the fields of social sciences and education, it was not possible for us as well to randomly pick the subjects to be included in the samples, we therefore first solicited schools to apply for participation in the studies. Although, as Stevenson and Stigler (1992) pointed out that "no sampling procedure is perfect" (p. 36), for there are so many factors involved in sampling, we tried our best to select, among the schools which applied, those which would be most representative of the majority of schools in the country based on our own judgment. That means, to maximize the generalizability of results, the inclusion of schools in the study was based on location, size, and socioeconomic status of the community surrounding the schools. In total, 13 schools and 28 teachers were in our sample (see more details below).

Schools

The 13 investigated schools are in 11 states across the US. They are in California, Colorado, Georgia, Oregon, Indiana, Illinois, Mississippi, Wisconsin, Pennsylvania, South Carolina and Texas, and located in semi-rural, rural, town, suburb, and inner city areas, with at least 2 schools in the same kind of area. Among them, one is a middle school, another is a junior high school, and the rest are high schools. The school sizes ranged from about 500 students to over 3000 students. Each school participated in one of the four field studies, except for one school in Pennsylvania, which took part in two studies for two different UCSMP textbooks.

Teachers

After the schools were chosen, a pair of teachers, one assigned to teach one UCSMP textbook in two classes, and the other to teach a traditional textbook already in place in other two classes, were nominated by each participating school for each course (the details of the

textbooks are given in Table I). The researchers of the study signed an agreement with the schools and the participating teachers before the formal start of the study.

In all, 14 teachers' (4 males, 10 females) classrooms using UCSMP textbooks, and 14 teachers' (8 males, 6 females) classrooms using non-UCSMP texts were observed, and all the teachers were also interviewed. All teachers' background, including both educational and professional experience, were collected later through a survey using a questionnaire. However, because in the UCSMP group, one was then a substitute teacher since the official teacher was on vacation, and in the non-UCSMP group, one teacher had left the school when the questionnaires were administered, no questionnaires were collected from these two teachers. Hence below we only present the information on 13 teachers in the UCSMP group and 13 in the non-UCSMP group.

Regarding teachers' educational background, all teachers had at least bachelor's degrees, and most had master's degrees in each group. Eight teachers using UCSMP, and nine teachers using non-UCSMP textbooks hold two or more degrees. All teachers took math, mathematics education, education or secondary education, or curriculum and instruction as their major, except one UCSMP teacher and three non-UCSMP teachers, who took math as a minor.

In terms of the highest degrees possessed, 7 teachers in the UCSMP group had Master's degrees, 6 Bachelor's degrees; in contrast, 9 in the non-UCSMP group had Master's degrees, 4 Bachelor's. By applying the chi-square test to these data, we found that the two groups of teachers were statistically equivalent ($\chi^2 = 0.65$, df = 1, $p < 0.420$).

As to teaching experience of these two groups of teachers, the average length of teaching any subject within the UCSMP group was 19.1 years with standard deviation (s.d.) of 6.33, and that of teaching mathematics was 17.4 years with s.d. of 9.60. Correspondingly, within the non-UCSMP group, the average was 19.3 years for teaching any subject with s.d. of 5.87, and 17.7 years for teaching mathematics with s.d. of 9.08.

Obviously, the above numbers indicate that there is no significant difference in the teaching experience of those two groups of teachers in terms of average years of both general

teaching experience and mathematics teaching experience. Actually, the probability value of t-test (for the difference of the average) and that of F-test (for the s.d.) are 0.943 (t = 0.073), and 0.164 (F = 1.787) for teaching any subjects, and 0.919 (t = 0.104) and 0.145 (F = 1.875) for teaching mathematics, respectively.

In addition, all teachers in our study were certified to teach mathematics.

It is important to note that because these two groups of teachers were statistically equivalent with respect to both educational background and teaching experience based on the indicators described above, we can significantly eliminate the influences of the difference of professional background on teaching strategies and therefore enhance the validity of attributing the difference of teaching strategies to textbooks, which is our main concern in this study.

Textbooks

Table I lists the textbooks used by the teachers in the UCSMP group and those used by the non-UCSMP group correspondingly.

Table I

Textbooks used by teachers in the UCSMP group and those used by teachers in the non-UCSMP group correspondingly.

Textbooks used by teachers in the UCSMP group (n=14)*	Textbooks used by teachers in the non-UCSMP group (n=14)
UCSMP *Transition Mathematics* (3)	Addison Wesley: *Pre-Algebra* (1) Heath: *Pre-Algebra* (1) Laidlaw: *Algebra I* (1)
UCSMP *Algebra* (3)	Houghton Mifflin: *Algebra: Structure and Method* (1) Prentice Hall: *Algebra* (1) Saxon: *Algebra* (1)
UCSMP *Geometry* (4)	Key Curriculum Press: *Discovering Geometry* (1) Houghton Mifflin: *Geometry* (2) Merrill: *Geometry* (1)
UCSMP *Advanced Algebra* (4)	Addison-Wesley: *Algebra* (1); Merrill: *Algebra II* (1); Houghton Mifflin: *Algebra and Trigonometry* (2)

*The figures in parentheses are the numbers of teachers using the textbooks.

From the table, we can see that, relatively, almost all textbooks used by teachers in the non-UCSMP group were rather traditional; that is, in some sense, almost none of them could be called belonging to a reformed curriculum, though many of them have been very standard and widely-used and highly recommended. Although we shall not compare in detail the features of UCSMP textbooks with that of all individual non-UCSMP textbooks used in this study, it is important to point out that there are several basic elements distinguishing UCSMP texts from most other existing texts, including wider scope of content, more reading and problem-solving, more applications, integrated use of technology, a multidimensional approach to understanding, a new instructional format, and containing projects (for more details, see Usiskin and Senk, 1995). While all features may more or less contribute to teachers' teaching practice including the choice of instructional content and teaching methods, and some (e.g., wider scope of content, and more applications) may have more influence on the content taught, we expect that the following three special features will have more direct influence on teachers' teaching strategies or, in another word, methods.

1. Use of Technology. The rapid development of technology is one of the most important forces in the reform of school curriculum. Taking advantage of today's widely available technology is one of the underlying beliefs of UCSMP. Students are expected to use scientific calculators in all courses, and to use automatic graphers (graphics calculators or computers) beginning in UCSMP *Algebra* and on daily-basis in *Advanced Algebra* . Automatic drawers (e.g., a geometry drawing software called "GeoExplorer" designed specially for UCSMP textbooks by its publisher, ScottForesman) are also strongly recommended for use with *Geometry*. Meanwhile, every UCSMP textbook has its corresponding technology-using materials (called technology masters) for teachers' use in classrooms.

2. Cooperative Learning. Cooperative learning is highly integrated and encouraged in all UCSMP textbooks. Table II shows statistics of the opportunities for cooperative learning

(small group work) provided by UCSMP textbooks based on the suggestions contained in the officially published second edition of the textbooks (McConnell *et al.*, 1996; Senk *et al.*, 1996; Usiskin *et al.*, 1995; Usiskin *et al.*, 1997), which are based on the pilot edition used by the teachers in this study. As one author of this article was an editor of the formal second edition, we believe that, as one can understand, the pilot and the formal published editions are basically similar. In other words, there are no significant differences between them.

Table II
Opportunities for cooperative learning (group work) provided by UCSMP textbooks.

	Transition Mathematics	*Algebra*	*Geometry*	*Advanced Algebra*	Total
No. of all lessons	114	114	115	123	466
No. of lessons with opportunities for cooperative learning (LWOCL)	80	92	83	98	353
Percentage of LWOCL in all lessons (%)	71.2	80.7	72.2	79.7	75.8

Note: the data are based on the suggestions contained in the officially published second edition textbooks.

Furthermore, there are "In-Class Activities" in most chapters and "(In-Lesson) Activities" in many lessons, most of which require group work.

3. Reading. UCSMP stresses the importance of reading the text for students to understand mathematics in math courses and to read technical matter in the world at large. Reading mathematics is explicitly required in the textbooks and each lesson includes selections for students to read, and contains questions and problem sets applying the reading.

Students

In total, there were 615 students, 311 in 14 classrooms using UCSMP textbooks and 304 in 14 classrooms using non-UCSMP ones, involved in this study. Among the 14 classes in the UCSMP group, 3 used UCSMP *Transition Mathematics*, 4 *Algebra*, 4 *Geometry*, and 4 *Advanced Algebra*; while in the comparison group, the same number of classes used the corresponding non-UCSMP textbooks. The average size of the 28 classrooms observed was 22 students, with the UCSMP classrooms ranging from 14 to 33 students with a mean of

22.2, and the non-UCSMP classrooms from 14 to 30 with an average of 21.7, very close to each other.

The ethnic composition of classes differed widely. Ten classes consisted of all white students, 19 having mixed ethnicities (among them, 9 having considerably more white students, 4 having considerably more minority students of mainly African-American and Latino origin). They were distributed nearly equally in both groups. The grade levels of students ranged from 7 to 12. To a great extent, we believe that the whole student population in this study is very representative of the student cohort.

Instruments

Three instruments were used in each study. They were observation schedules, teacher interviews and teacher background questionnaires. These instruments were developed by a group of researchers at UCSMP. The persons who went to observe classes and interview teachers were given some training sessions. They were also provided with a practical session of one classroom observation and two sessions of teacher interviews in one Chicago suburb school . The aim of developing these instruments and providing training sessions was to make sure that all the observers looked for the same criteria in the classrooms observed and asked the same questions and in the same style to all the teachers.

At each site visit, the classes were observed with the following general focus:

- characteristics of school and classroom
- goal(s) of the lesson
- teaching strategies employed in the classroom
- reading strategies employed in the classroom
- writing strategies employed in the classroom
- student use of mathematical terms and mathematical language
- locus of learning activity
- level of student interest

- use of calculators and other technology in mathematics classroom

- general pace

In addition to classroom observations, the site visits were used to interview the pilot and comparison teachers, and to talk to site coordinators and the principals.

The background questionnaire was administered to all the pilot and comparison teachers to determine their level of education, subjects studied at degree level, teaching experience, subjects taught, certification and their general opinion on different aspects of the course.

Data Analysis

As we mentioned earlier, the purpose of this study is not for providing an overall evaluation of the textbooks but investigating specifically if there are different patterns of teaching strategies between teachers using UCSMP textbooks and those using non-UCSMP textbooks, and if so, how they are related to the features of UCSMP textbooks. For this purpose, we particularly focused on the data which we believe have direct relation to our theme in both the observation and the interview records, although all the information provided from the field tests also received our attention.

Specifically, in the observation records, we mainly focused on the data, reported by the observers from the "Classroom Observation Report", about the "Teaching Strategies" which were analyzed in terms of "Lecture demonstration, Reading of textbook, Seatwork, Small Group Work, Whole-class discussion, Going over homework, Laboratory work, Other instructional activity, and Non-instructional activity". As all of the terms have been commonly used by the researchers as well as teachers, and we did not put unusual meanings on them, we will not make further explanations of these terms for parsimony.

In addition, because we thought the item of "Locus of activity in the class" in the observation records was largely related to a teacher's teaching strategy and reflected that how

the teacher viewed and dealt with the classroom control and organization of instruction, we also analyzed the data collected on this question.

Our analysis of the interview records focused on following questions in the "Teacher Interview Schedules".

Question A: "Was the class period I observed typical? if not, how? What would a typical class period be like? (Probe: Are there other periodic activities you have been doing in the classroom which you did not do today?)"

Question B: "What teaching methods do you use in your class teaching? (Probe: Do you use group work, technology etc. in the classroom? If yes, what do you think about them? If no, why not?)"

Question C (for UCSMP group only): "Some people have suggested that the UCSMP textbook (*Transition Mathematics; Algebra; Geometry;* or *Advanced Algebra*, respectively) requires teachers to adapt their teaching style. From your experience do you think this is true?"

Statistically, the data were analyzed by using chi-square test and the two-tailed t test.

Results and Discussions

Classroom Observation Data

Based on the data collected from the observation records, Table III below presents the results on the average amount of time devoted in the classrooms to different teaching strategies/activities by teachers using UCSMP textbooks and those using non-UCSMP ones. The probability values of t-test on their differences are also included.

From Table III, it is clear that the two strongest differences in teaching strategies employed by the teachers using UCSMP textbooks and by those using non-UCSMP materials were in "lecture demonstration" and in "group work". In the UCSMP group, the teachers on average used only 16% of the classroom time on "lecturing", while in

Table III

The average amount of time devoted in classroom to different teaching strategies/activities by teachers using UCSMP textbooks and those using non-UCSMP ones.

Teaching Strategies/Activities	UCSMP Mean (%)	UCSMP S. D	Non-UCSMP Mean (%)	Non-UCSMP S. D	Diff.	t	p<
Lecture demonstration	16.0	15.25	35.79	29.53	-19.79	2.31	0.038*
Reading of textbook	5.14	11.29	1.07	4.01	4.07	1.28	0.2213
Seatwork	14.64	17.92	26.36	25.54	-10.9	1.44	0.1733
Small group work	23.93	30.21	4.86	13.21	19.07	2.23	0.0443*
Whole-class discussion	4.64	8.42	5.50	12.77	-0.86	0.21	0.8358
Going over homework	18.43	17.82	16.36	16.80	2.07	0.32	0.7542
Laboratory work	1.00	3.741	0	0	1.00	1.00	0.3356
Other instructional activity	9.50	15.95	7.29	14.35	2.21	0.39	0.7025
Non-instructional . activity	6.79	10.87	4.64	5.71	2.15	0.66	0.5213

Note: N = 14, df = 13. *significant at the 0.05 level.

the non-UCSMP group, the average time used on this activity was nearly 36%, which is more than double the time devoted by their UCSMP counterparts. On the other hand, the UCSMP group spent four times more time on the "group work" than their non-UCSMP counterparts. Both of the differences are statistically significant at the 0.05 level.

To explain these differences, we believe that the special feature of "cooperative learning" in the UCSMP textbooks is not only very consistent with, but also the essential reason that the teachers using the UCSMP books spent much more time on "group work". The data from the interviews also support this. For example, when one UCSMP geometry teacher was asked: "Do you think the book lends itself more towards working in groups than other books"? He said, "Yes, definitely, because there are really specific things in there - in-class activities, do this with a group, and this is important". (More analyses of the interview data will be provided later). Also, these teachers' spending much less time on lecturing is quite consistent and related to the fact that the UCSMP texts encourage classroom activities

such as "group work" and "(students') reading of textbooks". From the perspective of their pedagogical information implied for classroom teaching, these features certainly discourage teachers' "lecturing" and objectively reduce the time that they could allocate to that activity in practice. The interview data which we will discuss later also show this kind of relation.

Although the differences in both "reading of textbook" and "seatwork" shown in the table are not statistically significant at the 0.05 level, we think they are still considerable and should not be ignored. In comparison, the UCSMP group teachers allocated considerably more time for students to "read" the textbooks, and less time to do "seatwork", which is obviously consistent with the characteristics of the UCSMP textbooks described earlier.

Because UCSMP textbooks regularly include a good number of review questions of previous lessons at the end of every lesson, we expected that the classrooms using the textbooks would also spend more time on reviewing the homework. However, the result of this study shows that there was little difference between the teachers using UCSMP books and those using other textbooks. Probing this result further, we think that even though the UCSMP group teachers assigned all the review questions to students for homework, they still did not necessarily spend much time to review this kind of homework in the classrooms because possibly the students could do the homework well and brought few questions to the classrooms about the homework. In this sense, the fact that UCSMP textbooks include a lot of review questions only suggests that students would do more questions of this type, but not that the teachers have to spend much more time on those questions in the classrooms. Also, there is little difference in the average time spent on "whole class discussion" by the UCSMP teachers and their non-UCSMP counterparts.

As there was only one teacher in the UCSMP group, and no teachers in the other group, using "laboratory work" as one of the teaching strategies (the students in that class explored how to use the trace feature of TI-81 calculators to find the values of functions), also the probability value is relatively high, we have no strong reason to say that there is much difference between the two groups of teachers. Possibly more studies with larger samples and

more number of observations are needed if we want to get further conclusions in this aspect.

Among the "other instructional activities" observed in the classrooms were assigning homework, teachers' leading discussion, classroom quiz, etc. The "non-instructional activities" included announcements, setting up the classes, management of the classes, and the like. In some sense, those kinds of activities are to lesser degree related to "teaching strategies". But anyway, they are components of classroom activities. Table III shows there is little difference in the amount of time spent on them in the classrooms taught by the two groups of teachers. These results are consistent with our expectations.

Figure 1 shows graphically the comparison of the average time devoted by these two groups of teachers to different teaching strategies/activities.

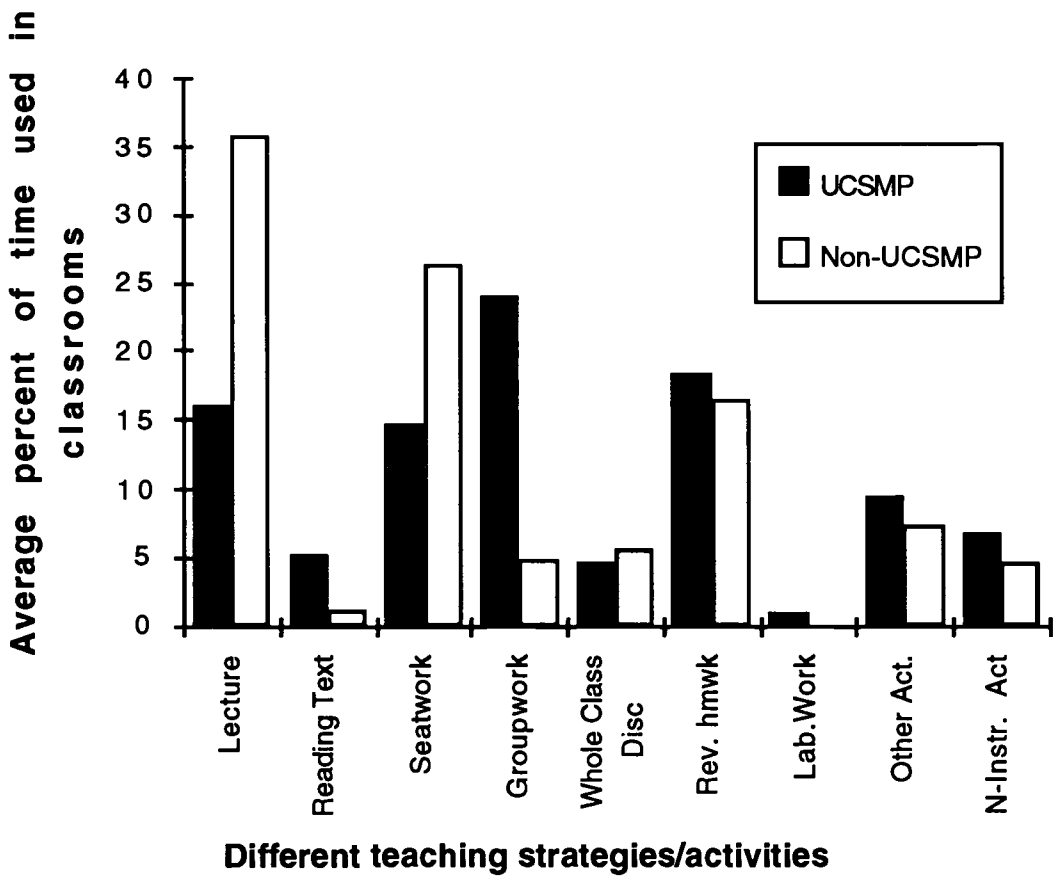

Fig. 1. Average percent of time used in classrooms for different teaching strategies/activities by teachers using UCSMP textbooks and those using non-UCSMP textbooks.

Table IV presents the data on the "Locus of classroom activity". The results are very remarkable. In the UCSMP group, there were more than 40% classrooms in which the students were the locus of the classroom activities. However, there were no teachers in the non-UCSMP group having such kind of lessons, and most teachers (71.4%) still dominated the classrooms, while only two teachers (14.3%) in the UCSMP group did so. According to the Chi-square test value, we can see that these two groups of classes were significantly different with regard to the locus of classroom activities.

Table IV

The locus of classroom activities in the classrooms observed.

	UCSMP Group (n=14)	Non-UCSMP Group (n=14)	Chi-square test
Teachers	2 (14.3%)	10 (71.4%)	$\chi^2 = 11.73$, df = 2, $p < 0.01$
Teachers/Students*	6 (42.9%)	4 (28.6%)	
Students	6 (42.9%)	0 (0%)	

*Sometimes the locus was the teacher, and sometimes the students.

We believe the differences are closely related to, as well as consistent with, the structure of teaching strategies presented in Table III. Namely, the teachers using UCSMP textbooks allocated more time to group work, reading textbooks; in those kinds of activities the locus would be more possibly on the students. In contrast, non-UCSMP group teachers spent much more time on lecture, in which kind of activity the locus would be more possibly on the teachers themselves.

Teacher Interview Data

Now we turn to the data from the interviews. Because each classroom was observed only once, it is important to know if the class observed was typical. Thus, in the interviews, each teacher was emphatically asked "Was the class period I observed typical?" and "Are there other periodic activities you have been doing in the classroom which you did not do today?"

For the first question, among 27 teachers (the data for one non-UCSMP teacher was missing), 23 (85.2%) answered "typical" or "very (pretty) typical", 3 (11%) answered "basically typical", and only one non-UCSMP teacher answered "not typical" but in terms of students' behavior. For the second question, 6 teachers in the UCSMP group, and also 6 in the non-UCSMP group, answered that in other days they would have group work. Only one UCSMP teacher said there was less lecturing time (the actual percentage on the observation day was 38%) in other usual class periods (note that the difference of lecturing time between UCSMP and non-UCSMP would be even larger if the actual percentage for that teacher were less than 38%). Therefore, we think the above comparative results are quite reliable.

When interviewed, 14 teachers in the UCSMP group, and 13 in the non-UCSMP group were asked the question "Do you use group work in the classroom?". The results reveal that all (14, 100%) teachers in the UCSMP group used "group work" as one of their teaching strategies; but in the non-UCSMP group, there were only less than half (6, 46.1%) teachers who used this strategy, and nearly one third (4, 30.8%) teachers rarely or never used it in their classrooms, and the rest (3, 23.1%) used sometimes. A chi-square test for these data suggests that the difference in teachers' employing "group work" in their classrooms was significantly associated with the textbooks they used ($\chi^2 = 10.18$, $df = 2$, $p < 0.01$), which is consistent with the findings from the classroom observations reported earlier.

Table V describes the data about teachers' using "technology", i. e., calculators and computers, as their teaching strategies. In the UCSMP group, nearly 60% of the teachers used computers, and all teachers utilized computers or calculators in their classrooms. In contrast, only about 17% teachers in the non-UCSMP group used computers, and less than two thirds used computers or calculators in the their teaching activities. Furthermore, more than 40% teachers in the non-UCSMP group had not used even calculators in their classrooms in the courses they taught then. The result of chi-square test indicates that these two groups of teachers were significantly different in using computers and calculators.

Table V

The numbers and percentages of teachers using technology (computers and calculators) in classrooms, collected from the interviews.

	UCSMP Group (n=14)	Non-UCSMP Group (n=12)*	Chi-square test
using computers	8 (57.1%)	2 (16.7%)	
using calculators only	6 (42.9%)	5 (41.7%)	$\chi^2=8.588$, df = 2, $p<0.05$
using none	0 (0%)	5 (41.7%)	

*Interviews with 13 teachers were collected and one of them was not asked the question.

The interviews also revealed the relationship of the use of technology in the classrooms to the textbooks used. For example, one algebra teacher using a non-UCSMP text said,

> The book doesn't really offer itself much for any calculator use except for when you are doing maybe percents or something like that.

Considering UCSMP textbooks' feature in "use of technology", we think that the strong commitment of UCSMP textbooks to integrating technology did play an important role in making such a difference.

The last yet very important result we want to discuss is about the question: "Some people have suggested that the UCSMP textbook (*Transition Mathematics*, or *Algebra*, or *Geometry,* or *Advanced Algebra*, respectively) requires teachers to adapt their teaching style. From your experience do you think this is true?". Obviously, this question is directly related to the theme of this study. Of the 13 teachers in the UCSMP group who were asked the question, 11 (84.6%) teachers responded: "Yes" or "Definitely". For example, one said:

> Yes, I had to get used to not teaching students everything. I wanted them to read, I know UCSMP wants them to read and figure it out first before the teacher teaches them, and this is difficult after 25 years of being a teacher. But after I got used to that system, and realized that it worked, I really liked it.

Another teacher replied:

> Definitely. If you see three of my classes (using different texts) probably no two are the same.....The change in my teaching style is that I'm not lecturing anymore.

Still another answered:

> Yes. Because in the previous Geometry courses that I've taught, normally I would start each lesson by kind of lecturing about that particular lesson and we would do some discovery activities, maybe as it pertained to the theorem or the concept for that particular lesson. In this UCSMP materials, I've tried to have the students read the material first, and also try to do as much of the problems as they can before I really said too much about it. So I haven't done near the lecturing that I had with the other material, with the other series. So that from that part I had to change my approach that way.

With regard to the remaining two teachers who were asked the same question, one algebra teacher said:

> A bit. Not as much as I thought when I heard I was doing this last summer.

But he believed it did support a particular teaching style that teachers "have to be open minded and a little bit looser"; the other advanced algebra teacher answered:

> I have been trying to adapt my teaching style from a non-traditional to a more non-traditional, ... to adapt away from a lecture format anyway. And one of the reasons that I chose this material was I felt that it limited itself to that much better than other materials. So I am not sure if it's the UCSMP that is helping me to change or I think it's really more I've used these materials because I think it's more open to different teaching styles.

Though this answer apparently contains the possibility that Krammer once conjectured in his study mentioned earlier that teachers might choose a textbook that resembled their preferred teaching style, we should point out that this was the only case in this study, and we did not find any more evidence from the date to support this kind of conjecture. Comparing this single case to all of the other answers, we strongly believe that in general the features of UCSMP textbooks did affect teachers' teaching strategies, and Krammer's uncertainty in his study can be largely removed in this study.

Finally, at the discretion of the observer, one teacher who taught algebra was not directly asked the same question, but a related one, "How do you feel about the content and teaching style advocated by the UCSMP"? The answer was

> I like it.... I liked the application, I liked the technology involved, and I would really like to be able to teach out of this book again.

From this perception, it seems plausible that the textbook also did have influence on his teaching style.

In short, from the data on teachers' perception revealed in the interviews described above, we conclude that, overall, UCSMP textbooks did have an impact on teachers' teaching strategies and the influence is closely related to the features of the books, which convey pedagogical orientations to teachers and provide them with certain encouraging or discouraging curricular environment for utilizing different teaching strategies.

Conclusions and Implications

As we pointed out earlier, this study is based on two main data resources: classroom observations and teacher interviews. It is remarkable, according to the aforementioned analysis, that both resources consistently led to some important results. In general, we believe there are several conclusions which can be drawn from this study.

First, there were important differences in the teaching strategies between teachers using UCSMP textbooks and those using non-UCSMP textbooks. Mainly, compared with teachers using non-UCSMP textbooks, teachers using UCSMP books spent significantly more time on "group work", and considerably more time on the reading of textbooks; at the same time, they devoted significantly less time to "lecturing", and considerably less time to "seatwork" in their classrooms.

Second, compared to teachers using non-UCSMP materials, there were significantly more teachers using UCSMP textbooks who employed technology, including computers and calculators, in their teaching strategies.

Third, the differences in the teaching strategies between the UCSMP group teachers and the non-UCSMP group teachers were closely related to and consistent with the special features of UCSMP textbooks compared with the other textbooks; and according to the

perception of teachers using UCSMP textbooks, the textbooks did have important influence on their teaching strategies employed in their classrooms.

As a number of studies we reviewed revealed, textbooks can, to more or less degree, have influence on the content of teaching. This study suggests that textbooks can affect not only what to teach, but also how to teach. Textbooks with different features can convey pedagogical orientations to teachers and provide them with certain encouraging or discouraging curricular environment for utilizing different teaching strategies. Hence, their role in teachers' teaching practices should be adequately recognized by textbook authors, curriculum reformers and designers, as well as school teachers and administrators.

Also, a further implication of this study for policy matter is that it would be difficult or less successful to reform teachers' teaching methods without correspondingly reforming the textbooks they are using at the same time, because as this study shows, textbooks do affect teachers' teaching strategies.

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