THE USE OF TRADITIONAL AND CONTEMPORARY INSTRUCTIONAL STRATEGIES AND MATERIALS IN THE ELEMENTARY MATHEMATICS CLASSROOM

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Abstract

Elementary school teachers were surveyed about the strategies and materials they use to teach elementary school mathematics. A list of twenty strategies and materials derived from the Changes in Content and Emphasis sections of the National Council of Teachers of Mathematics (NCTM) Curriculum and Evaluation Standards for School Mathematics were examined [1]. These strategies represent both contemporary and traditional approaches to the teaching of mathematics. Teachers were asked to respond to each survey item by indicating how often these strategies were used in their classrooms.

The findings were compared to the goals of the NCTM Standards to assess how much progress has been made in the effort to influence elementary school mathematics instruction. Compared to these goals and the call for change in instructional strategies by the Standards, results seem to be mixed with progress in some areas and not in others. Teacher-centered, whole-group instruction remains the dominant pedagogical form, but approaches using concrete materials seem to be on the increase.

Introduction

Over the past few decades, much attention has been focused on changing the way mathematics is taught. Nationwide programs, as well as state and local initiatives, have been launched to effect these changes. One wonders how much these efforts have impacted the way elementary school mathematics is taught.

It has been more than a decade since the publication of the NCTM Standards [1]. Has there been change in the way mathematics is taught in the nation's classrooms? The answer seems to be "yes ... somewhat," but there is little research that would indicate how much. In 1992, NCTM conducted a pilot study titled, "The Road to Reform in Mathematics Education: How Far Have We Traveled?" [2]. This pilot study found that about half of the teachers said that state or district testing programs dictate what they teach. In addition, the study found that more than half of the teachers organize their curriculum around the textbook. Only in grades K-4 did more than half of the teachers

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responding indicate that the use of manipulative materials was one of their frequently used activities. So, how far have we come? How much impact has all of this effort had on mathematics instruction in the elementary classroom? This study is an attempt to discover which of the many traditional and contemporary strategies and materials are currently used in elementary school mathematics instruction [2].

The Sample

The population for this study was the elementary classroom teachers (grades 1-6) in a mid-Atlantic state. A sample of 381 returns were needed [3]. Based on a projected return rate of approximately 70%, a simple random sample (n = 600) of this population was requested from the Office of Information Reporting and Technology Services of the State Education Department [3]. The initial sample of 600 was reduced to 500 by randomly selecting and removing 100 names. These names were held in reserve to be used as replacements for teachers who responded that they did not teach mathematics or for surveys that could not be delivered.

Data Collection

Data were collected by means of a mailed survey questionnaire. Dillman's Total Design Method was used in the data collection process in an effort to achieve the necessary return rate [4]. A total of 529 surveys, including replacements for teachers who did not teach mathematics, were mailed. Of those, sixteen were returned because they were undeliverable. Of the remaining 513 surveys, 438 were returned from teachers in the sample for a return rate of 85.4%. Of those returned by teachers, 413 taught mathematics. This number served as the basic n for the statistical procedures in this study.

The Survey Instrument

The survey instrument consisted of a list of nineteen materials and strategies. This list included items that represent both traditional and contemporary materials and instructional strategies. Table 1 shows the materials and strategies, and their designation as contemporary or traditional. In Tables 2-5, the list is coded with (C) for contemporary or (T) for traditional to assist the reader with identification. There were also a number of demographic items.

The items comprising the list of materials and strategies were initially derived from the Summary of Changes in Content and Emphasis sections of the *Curriculum and Evaluation*

Standards for School Mathematics [1]. Teachers responded to these items by making the appropriate choice from a Likert scale that best described the frequency with which they used the indicated strategy or material. The Likert scale selections were: 1) not at all; 2) rarely; 3) sometimes; 4) often; and, 5) very often.

Table 1
Designation of Strategies and Materials

Contemporary Strategies	Traditional Strategies
Manipulative (concrete) materials	Teacher-centered, whole-class instruction
Problem solving instructional approach	Worksheets/workbooks/skillbooks
Cooperative learning	Computational skills instructional approach
Integration of mathematics with other subjects	Mathematics textbook
Extended problem-solving tasks	Memorization of number facts and algorithms
Computers	Competitive activities among students
Journal writing	Timed tests of number facts
Class presentations by students	Grouping by ability
Portfolio assessment	
Calculators	
Student interviews	

Treatment of Data

Frequencies, means, and standard deviations were calculated to ascertain the extent to which teachers reported using each of the listed strategies and materials. These descriptive statistics were calculated for several configurations of the set of teachers who responded to this survey. These configurations consisted of the complete set of teachers, primary teachers, and intermediate teachers.

A number of traditional divisions of the elementary grades exist. Grouping the levels as primary and intermediate is perhaps one of the most common. With this in mind and upon examination of these results, it was decided to perform the same set of calculations on these two different configurations: teachers of primary (1-3) and intermediate (4-6) grades, as well as the whole set (grades 1-6). The set was also divided into individual grade levels, calculating descriptive statistics for each grade level (1-6) separately.

Reported Use of Strategies and Materials

Table 2 shows the extent to which teachers reported using each of the listed strategies and materials. The last two columns were created from the data in order to show two levels of use by classroom teachers. The first of them, titled "Use—at least moderate" (moderate), is intended to provide an indication of the percentage of teachers using the strategy or material at least in a marginal way. This column was computed by adding the percentages for "sometimes," "often," and "very often." The second of these columns, titled "Use—Frequent" (frequent), is intended to provide an indication of the percentage of teachers using the strategy or material in an important way. This column was computed by adding percentages for "often" and "very often." Generally speaking, most teachers responding to this survey reported substantial use of some contemporary strategies.
Manipulative materials were reported to be used at least moderately by 93.1% of the teachers. Frequent use was reported by 59.4% of the teachers. An instructional approach based on problem solving was reported to be used at least moderately by 96.1% of the respondents, while 62.2% reported using this strategy frequently. Cooperative learning was reported to be used at least moderately by 94.9%, and frequently by 53%. Respondents reported using integration of mathematics with other subjects moderately at the 91.5% value, and frequently at the 52% value. Extended problem-solving tasks were reported to be used moderately by 86.5%, and frequently by 48.2% of the subjects.

Teachers did not report substantial use of some of the other contemporary strategies and materials. Journal writing, student presentations, portfolios, calculators, and student interviews were all used frequently by less than 23% of the respondents, even though these strategies are favored by the current movement in mathematics education [1].

Table 2
Mean, Standard Deviation, Percentage of Moderate Use, and Percentage of Frequent Use for Teachers in Grades 1-6, Listed in Descending Order by Mean

Strategy or Material	M	SD	% Use at Least Moderate	% Use Frequent
Teacher-centered, whole-class instruction (T)	4.19	0.80	98.0	81.0
Worksheets/workbooks/skillbooks (T)	3.99	0.94	94.1	69.8
Manipulative (concrete) materials (C)	3.83	0.96	93.1	59.4
Problem solving instructional approach (C)	3.78	0.82	96.1	62.2
Computational skills instructional approach (T)	3.70	0.78	95.4	60.0
Mathematics textbook (T)	3.69	1.41	80.5	63.9
Cooperative learning (C)	3.64	0.83	94.9	53.0
Integration of mathematics with other subjects (C)	3.55	0.84	91.5	52.0
Extended problem-solving tasks (C)	3.47	0.96	86.5	48.2
Memorization of number facts and algorithms (T)	3.29	1.09	79.1	42.1
Computers (C)	2.92	1.25	66.4	31.0
Competitive activities among students (T)	2.79	1.08	62.7	23.7
Timed tests of number facts (T)	2.75	1.27	57.4	29.8
Journal writing (C)	2.57	1.30	49.6	22.2
Class presentations by students (C)	2.55	1.10	52.3	19.1
Grouping by ability (T)	2.42	1.18	45.7	16.2
Portfolio assessment (C)	2.40	1.27	45.5	20.8
Calculators (C)	2.40	1.11	49.6	15.0
Student interviews (C)	2.09	1.04	32.6	8.9

Scale of 1 to 5

It would seem from these results that strategies such as manipulative materials, problem-solving instructional approaches, cooperative learning, integration with other subjects, and extended problem-solving tasks have become an important aspect of the instructional process in many elementary mathematics classrooms. In a climate of high stakes testing that exists even in elementary classrooms, teachers have become more selective about the strategies they use. Perhaps this is an indication that the strategies named above have value to teachers preparing students for high stakes testing. However, instruction utilizing journal writing, student presentations, portfolios, calculators, and student interviews has not found an important place in elementary classrooms.

Perhaps teachers are unfamiliar with or untrained in the use of these strategies. It is more likely, however, that teachers do not view them as productive in the current climate.

Two traditional strategies—teacher-centered, whole-class instruction and worksheets/workbooks/skillbooks—were reported to be used most frequently of all the strategies in this study. Teacher-centered, whole-class instruction was reported by far to be the most frequently used instructional strategy. A very high 98% of the participants indicated using this approach at least moderately and 81% said that they used it frequently. The other tactic, worksheets/workbooks/skillbooks, is one which contemporary curriculum initiatives encourage teachers to use *less* frequently; however, it is indicated as the second most frequently used approach. A high level, 94.1%, of participating teachers said that they employed worksheets/workbooks/skillbooks at least moderately, and 69.8% said they used them frequently.

An initial reaction to the picture of a teacher-centered elementary mathematics classroom focused on paper and pencil practice is discouraging. If these results are an indication that change takes place slowly, then we need to continue efforts to produce change. If these results indicate a reaction to the current testing climate, then we need to examine the nature of the assessments and the way teachers and administrators have interpreted them. If it is true that testing (or how testing is perceived) drives instruction, perhaps more creative and thought provoking assessments will foster more creative and thought provoking instruction.

Table 2 depicts data collected for teachers in grades 1-6. This presents an overall picture of the elementary school; however, it is possible that teachers in individual grades or groups of grades think differently about the materials and strategies used in mathematics instruction. Schools are frequently organized as primary (1-3) and intermediate (4-6) schools. Teachers are frequently grouped as primary (1-3) and intermediate (4-6) teachers. Since the primary and intermediate configuration exists in many school organizations, it was decided to examine the data when separated into these categories. Table 3 shows the extent to which primary (grades 1-3) teachers reported using the listed strategies and materials. Table 4 presents the extent to which intermediate teachers reported using the listed strategies and materials. The statistics in the "use at least moderate" and "use frequent" columns have been derived in the same way as described for Table 2. The means and standard deviations are those calculated for the separated groups.

Table 3
Mean, Standard Deviation, Percentage of Moderate Use, and Percentage of Frequent Use for Teachers in Grades 1-3, Listed in Descending Order by Mean

Strategy or Material	M	SD	% Use at Least Moderate	% Use Frequent
Teacher-centered, whole-class instruction (T)	4.17	0.78	98.8	79.7
Manipulative (concrete) materials (C)	4.14	0.86	97.9	73.3
Worksheets/workbooks/skillbooks (T)	3.99	0.92	94.5	65.7
Problem solving instructional approach (C)	3.79	0.85	95.8	61.1
Integration of mathematics with other subjects (C)	3.69	0.81	94.1	60.2
Computational skills instructional approach (T)	3.67	0.79	93.7	58.5
Cooperative learning (C)	3.62	0.84	94.4	51.2
Extended problem-solving tasks (C)	3.44	0.99	84.0	46.7
Mathematics textbook (T)	3.39	1.56	70.4	56.4
Memorization of number facts and algorithms (T)	3.21	1.12	75.4	39.4
Computers (C)	2.94	1.22	67.4	30.5
Journal writing (C)	2.68	1.34	52.5	24.1
Timed tests of number facts (T)	2.61	1.33	50.9	27.6
Competitive activities among students (T)	2.61	1.05	57.3	16.6
Portfolio assessment (C)	2.57	1.28	52.1	24.6
Class presentations by students (C)	2.5	1.11	48.7	16.5
Grouping by ability (T)	2.35	1.11	43.7	13.6
Student interviews (C)	2.14	1.06	34.4	10.2
Calculators (C)	2.11	1.06	38.1	8.0

Scale of 1 to 5

A comparison of Table 3 with Table 4 revealed some of the similarities and differences regarding the use of the listed strategies and materials between primary and intermediate teachers. The most striking observation was the prevalence of teacher-centered whole-class instruction. This approach topped the list for both groups. Primary teachers reported using the teacher-centered technique moderately at 98.8%, and frequently at 79.7%. Intermediate teachers reported using the whole-class style moderately at 96.5%, and frequently at 82.7%.

Table 4
Mean, Standard Deviation, Percentage of Moderate Use, and Percentage of Frequent Use for Teachers in Grades 4-6, Listed in Descending Order by Mean

Strategy or Material	M	SD	% Use at Least Moderate	% Use Frequent
Teacher-centered, whole-class instruction (T)	4.22	0.83	96.5	82.7
Mathematics textbook (T)	4.06	1.06	92.5	72.4
Worksheets/workbooks/skillbooks (T)	4.00	0.96	92.6	74.2
Problem solving instructional approach (C)	3.76	0.79	96.5	63.2
Computational skills instructional approach (T)	3.75	0.76	97.7	62.1
Cooperative learning (C)	3.66	0.82	95.4	54.6
Extended problem-solving tasks (C)	3.51	0.93	89.7	50.0
Manipulative (concrete) materials (C)	3.41	0.93	86.2	40.2
Memorization of number facts and algorithms (T)	3.41	1.04	84.5	46.0
Integration of mathematics with other subjects (C)	3.35	0.84	87.9	40.8
Competitive activities among students (T)	3.03	1.07	70.1	32.7
Timed tests of number facts (T)	2.92	1.18	65.5	32.7
Computers (C)	2.89	1.29	64.9	31.6
Calculators (C)	2.78	1.06	65.5	24.1
Class presentations by students (C)	2.60	1.09	56.9	22.4
Grouping by ability (T)	2.51	1.27	48.2	19.5
Journal writing (C)	2.41	1.24	45.4	19.5
Portfolio assessment (C)	2.18	1.22	36.8	16.1
Student interviews (C)	1.99	1.01	29.2	7.4

Scale of 1 to 5

Another strategy and material reported to be used frequently by both primary and intermediate teachers, as well as the whole group, was worksheets/workbooks/skillbooks. This method was third on the list for both groups of teachers. Intermediate teachers reported the use of these drill and practice tools moderately at 92.6%, and frequently at 74.2%. Primary teachers reported their use at moderate (94.5%) and frequent (65.7%).

Before excessive criticism is heaped on the teacher-centered, practice-oriented mathematics classroom, it is important to recognize the nature of the skills and content taught at the elementary level. For much of the content and many of the skills, a high level of teacher input and guided practice represents good pedagogy. It is hoped, however, that the high levels for teacher-centered classroom and workbooks do not indicate that these strategies are used when more thought provoking and student-centered strategies would be more appropriate and productive.

Interesting findings were represented by those approaches that data showed to be used with different frequencies by primary and intermediate teachers. The mathematics textbook was such a case. Use of the text was reported second on the intermediate list and tenth on the primary list. Intermediate teachers reported using the textbook moderately at 92.5%, and frequently at 72.4%. Primary teachers, however, reported using the book moderately at 70.4%, and frequently at 56.4%. It was also worth noting that the standard deviation for use of the mathematics textbook on the primary list was 1.56. This standard deviation was the largest of any listed in Tables 3, 4, or 5. This large standard deviation indicated considerable variability in the use of this material.

Table 5
Rank Order of Strategies and Materials for Whole Group and Each Grade Level

Strategy or Material	Gr1	Gr2	Gr3	Gr4	Gr5	Gr6	Gr 1-6
Teacher-centered, whole-class instruction (T)	2	2	1	1	1	2	1
Worksheets/workbooks/skillbooks (T)	5	3	2	3	2	3	2
Manipulative (concrete) materials (C)	1	1	8	9	9	12	3
Problem solving instructional approach (C)	6	4	3	5	4	4	4
Computational skill instructional approach (T)	7	6	7	4	6	5	6
Mathematics textbook (T)	10	10	6	2	5	1	7
Cooperative learning (C)	8	7	11	7	7	7	8
Integration of mathematics with other subj. (C)	3	8	9	11	11	9	9
Extended problem-solving tasks (C)	9	9	10	10	8	8	10
Memorization of number facts & algorithms (T)	14	11	4	6	10	13	11
Computers (C)	11	12	13	14	12	14	12
Competitive activities among students (T)	15	15	14	13	13	11	13
Timed tests of number facts (T)	19	14	12	12	14	16	14
Journal writing (C)	13	13	16	17	18	18	15
Class presentations by students (C)	16	16	15	16	16	15	16
Grouping by ability (T)	17	18	17	18	17	17	17
Portfolio assessment (C)	12	17	19	19	19	19	18
Calculators (C)	20	20	18	15	15	10	19
Student interviews (C)	18	19	20	20	20	20	20

The math book could almost be considered a classroom tradition. It seems difficult for teachers to conceive of teaching without it. So it is not surprising that it is ranked near the top of the list, particularly by intermediate teachers. The interesting aspect of textbook use is the great variability of use in the primary grades indicated by the large standard deviation (SD = 1.56). It appears that many primary teachers cling to the textbook tradition. It also appears that many primary teachers have found an alternative. An examination of Table 5, where strategies and materials are ranked in order of use for each grade level, gives an indication of what that alternative might be. The use of manipulative materials is ranked as the most frequent approach in both first and second grade. It is possible that many early primary teachers build their math program on a foundation of concrete experience. It is interesting that the use of concrete materials drops sharply in grade 3 (see Table 5) and continues to decline to grade 6. Perhaps this trend is reflective of the changing nature of the skills and content taught. It is more likely, however, that this trend reflects a change in teachers' beliefs about the effectiveness of concrete experience as an instructional strategy. One wonders if teachers, when faced with high stakes testing which begins in grade 3 in many states, return to the traditional strategies of controlled drill and practice.

The memorization of number facts and algorithms presented a different kind of pattern. This approach seemed to be marginally used except at grades three and four, where there was a rise in its reported use. The technique was ranked from tenth to fourteenth by grades 1, 2, 5, and 6. Its reported use peaked at grades 4 and 3 where it was reported sixth and fourth, respectively. When analyzing this trend, it is important to keep in mind the skills and content taught at these levels. This increase in reported use is consistent with the traditional expectation that students memorize their multiplication tables in grades three and four.

Conclusions

The NCTM standards and the various new state learning standards have encouraged teachers to use contemporary approaches more frequently and use less effective traditional approaches less frequently. A clear indication of progress in these areas would be welcome. It must be noted, however, that change in the use of strategies and materials for teaching elementary school mathematics is very difficult to assess. No other study of the strategies and materials used by elementary school teachers was found. The tenor of such documents as the 1989 NCTM Standards, the various state learning standards, and the core curricula for mathematics coupled with national efforts such as the 1992 NCTM study provide the only basis upon which to make comparisons.

Based on the results of this survey and the conditions indicated by these documents, progress in these areas is mixed.

It is also difficult to determine the impact of perceptions teachers and administrators have about high stakes testing. It is possible that teachers would use more varied instructional approaches in a climate where passing the test was not the central focus. The prevalence of the teacher-centered classroom, the textbook, and the workbook seems to indicate that teachers have chosen the traditional approach.

There are, however, a number of contemporary approaches that appear to have made encouraging gains. Specifically, manipulative materials, problem solving, cooperative learning, and integration of mathematics with other subjects seem to be well on their way to becoming standard classroom practices. There is also encouragement in the finding that strategies such as rote memorization of facts and algorithms are used appropriately instead of pervasively. It is also indicated here that some of the less effective traditional approaches seemed to be on the decline. Specifically, timed tests of number facts and grouping by ability were not reported to be important classroom strategies.

The way elementary school mathematics is taught is very important to all mathematics learning. Early experiences form the attitudes that older students and adults have about the nature of mathematics and their ability to learn it. It is important to continue to strive for an elementary classroom that fosters understanding and excites all young students about learning mathematics.■

References

[1] *Curriculum and Evaluation Standards for School Mathematics*, National Council of Teachers of Mathematics, Reston, VA, 1989.

[2] *The Road to Reform in Mathematics Education: How Far Have We Traveled?* National Council of Teachers of Mathematics, Reston, VA, 1992.

[3] R.V. Krejcie and D.W. Morgan, "Determining Sample Size for Research Activities," *Educational and Psychological Measurement*, **30**(3) 1970.

[4] D.A. Dillman, *Mail and Telephone Surveys: the Total Design Method*, John Wiley and Sons, Inc., New York, 1978.