The Teaching of Mathematics in British Columbia*

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Approximately 3,500 teachers of mathematics in elementary and secondary schools throughout British Columbia completed questionnaires dealing with their backgrounds and aspects of their teaching practices. Results indicate that, in general, teachers are well-prepared academically to teach mathematics but that there is little evidence of the impact of "new math" on the teaching of mathematics. Topics rated as most important by teachers were those dealing with arithmetic skills, and the most frequently used teaching techniques are total class instruction and teacher explanation.

On a demandé à environ 3,500 professeurs de mathématiques enseignant dans des écoles de niveau élémentaire et secondaire situées un peu partout en Colombie-Britannique de remplir un questionnaire au sujet de leur formation, de leur expérience et des divers aspects de leur pratique de l'enseignement. Les résultats démontrent qu'en général, les professeurs ont une bonne formation académique pour enseigner les mathématiques mais que l'impact qu'ont eu les "mathématiques modernes" sur l'enseignement des mathématiques n'est guère évident. Les sujets considérés les plus importants par les professeurs sont ceux qui ont trait à la maîtrise de l'arithmétique; aussi, les techniques d'enseignement les plus courantes sont les leçons données en classe et les explications fournies par le professeur.

Over the past two decades, extensive changes in both the content and the methodology of teaching school mathematics have been planned, recommended, and officially adopted in all of the provinces in Canada. In the period between 1965 and 1975, the so-called "new math" swept across the country bringing with it new content topics and recommendations for change in the methods and materials used in the teaching of mathematics. At the present time, the first surge of what has been termed a "back-to-basics" movement has begun to influence the field of mathematics education.

Throughout this period, little attention has been paid to assessing the extent of the impact of such changes and recommendations on the teaching practice of teachers of mathematics. Much has been written about the academic achievement of students who were taught the "new math," and any number of curriculum guides and inservice programmes have been produced encouraging teachers to adopt new teaching strategies. However, little if any evidence has been published in Canada concerning the impact of such guides and programs on teaching practice.

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A study conducted in the United States (Price, Kelley, & Kelley, 1977) collected information about teachers of mathematics and the teaching of mathematics. A questionnaire was developed and distributed to a sample of second- and fifth-grade teachers throughout the U.S. Completed forms were returned by 41% of the sample drawn. In summarizing their results, the authors state that "the overwhelming conclusion to be drawn from these findings is that mathematics teachers and classrooms have changed far less in the past fifteen years than had been supposed" (Price et al., 1977).

In order to obtain an indication of the way mathematics was being taught in British Columbia, questionnaires were developed (Robitaille & Sherrill, 1977) and administered to teachers throughout the province. A number of the items used on these instruments were adapted from items which appeared on an earlier version of the questionnaire used by Price et al. (1977).

Separate questionnaires were developed for elementary and secondary teachers, and these were mailed to approximately 3,500 teachers of mathematics throughout B.C. As is indicated in Table 1, over 85% of the questionnaires were returned completed.

TABLE 1

Questionnaire Return Rates

Grade	*Sent Out*	*Questionnaires Returned*	*% Completed*
1	625	532	85.1
3	625	521	83.4
5	625	561	89.8
7	625	530	84.8
Total Elementary	2500	2144	85.8
8	489	420	85.9
10	361	292	80.9
12	101	99	98.0
Total Secondary	951	811	85.3

NOTE: In B.C., elementary school consists of Grades K-7, and secondary school of Grades 8-12.

The questionnaires were subdivided into five major sections. Part I, Background and General Information, dealt mainly with teachers' academic and professional training and experience, their membership in professional associations, and their opinions regarding the importance of mathematics in the overall school curriculum. In Part II, Learning Outcomes, teachers were asked to rate the relative importance of a number

of objectives chosen from the B.C. Curriculum Guide for Mathematics. Part III, Classroom Organization, dealt with topics such as class size, time spent on mathematics per day, and grouping practices used. In Part IV, Classroom Instruction, teachers were asked to supply information concerning the resources, aids, and methods which they used in their teaching of mathematics. Part V was concerned with the use of textbooks for the teaching of mathematics. In this last section, teachers were also asked to rate the various prescribed textbooks on a number of factors such as reading level and number of exercises.

TEACHER BACKGROUND AND GENERAL INFORMATION

According to the questionnaire results, the average teacher of mathematics at the elementary school level (Grades 1, 3, 5, 7) has had just over four years of post-secondary education. In general, the number of years of training increases with grade level taught. About 14% of elementary teachers have had no professional training in the teaching of mathematics, and another 35% have not had such a course in the last ten years. In addition, slightly more than 25% of the elementary teachers indicated that they had taken no courses in mathematics beyond secondary school. On the average, the elementary respondents had 8.5 years of teaching experience.

The average teacher of secondary mathematics (Grades 8, 10, 12) has had slightly more than five years of post-secondary education. As with elementary teachers, an increase in years of schooling is generally accompanied by an increase in grade level taught. Almost 35% of teachers of secondary mathematics did not have mathematics as one of their major areas of undergraduate study. Among Grade 8 teachers this figure is almost 50%. Twenty percent of the teachers of secondary mathematics have had no training in the teaching of mathematics, and another 37% had such training over ten years ago.

From one point of view, the general picture that emerges at both the elementary and secondary levels is that mathematics is being taught by experienced teachers with extensive backgrounds in professional training. On the other hand, many of these teachers have had little or no training either in mathematics or in methods of teaching mathematics.

Teachers were asked to indicate to which of a number of professional associations other than the British Columbia Teachers Federation they belonged. These results are displayed in Table 2.

With the exception of the B.C. Primary Teachers Association, membership in professional associations is very low. It is particularly worrisome to note that, at both the primary and the intermediate levels, membership rates in associations specializing in the teaching of mathematics are extremely low. Even among secondary teachers, the rate of affiliation is not particularly high.

TABLE 2

Membership in Professional Associations (Percent)

Association[a]	*Primary*	*Intermediate*	*Secondary*
BCAMT	2.9	2.8	27.7
NCTM	0.3	1.2	10.3
PITA	3.5	25.6	n/a
Primary	56.0	1.7	n/a

[a] BCAMT is the B.C. Association of Mathematics Teachers, NCTM is the National Council of Teachers of Mathematics, PITA is the Provincial Intermediate Teachers Association, and Primary is the B.C. Primary Teachers Association.

LEARNING OUTCOMES

Teachers of Grades 1, 3, 5, 7, 8, and 10 were asked to rate the importance of a number of possible learning outcomes for their own grade levels. Many of these outcomes were quoted directly from the Mathematics Curriculum Guide (Curriculum Development Branch, 1978). Each item was rated on a five-point scale ranging from Very Important to Not Important.

About 90% of the learning outcomes were rated on the positive half of the scale. In other words, very few of the objectives were seen as unimportant. As might be expected, all of the computation-oriented objectives were given high ratings. On the other hand, all of the geometry objectives were given relatively low rankings by all four groups of elementary teachers.

All teachers were asked to rate the importance of 12 objectives for students completing secondary school by giving each objective a rating of 1 (optional), 2 (important, but not essential), or 3 (essential). These results obtained are summarized in Table 3.

On the whole there was considerable agreement between the elementary and secondary teachers concerning the relative importance of these topics. Of the three topics (5, 7, and 9) rated lowest, two deal with algebraic skills, and the third with the Pythagorean Theorem. All three of these topics are part of the secondary school mathematics curriculum. Of the six topics (1, 2, 3, 8, 11, and 12) rated highest, only one (11) could be considered part of the mainstream of topics in the current mathematics curriculum for secondary schools. The other five would not be considered part of that curriculum, but probably would be thought of as prerequisite skills or, in the case of the Item 12 in Table 3, as skills which students would acquire through some form of transfer of training.

On a similar item, teachers of secondary mathematics were asked to rate the importance of 21 objectives for students completing elementary school. These results are displayed in Table 4.

TABLE 3

Importance of Selected Objectives for Students Completing Secondary School

Topic	*Elementary Teachers*	*Secondary Teachers*
1. Whole number operations	3.0	3.0
2. Fraction operations	2.6	2.9
3. Decimal operations	2.7	3.0
4. Find areas and volumes	2.4	2.7
5. Use the Pythagorean Theorem	1.7	2.3
6. Solve linear equations	2.1	2.3
7. Solve quadratic equations	1.7	1.8
8. Use metric units	2.9	2.9
9. Evaluate algebraic expressions	1.9	2.3
10. Name geometric figures	2.3	2.4
11. Solve applications	2.7	2.7
12. Solve consumer items	2.9	2.9

Not unexpectedly, five of the seven objectives rated highest (1, 3, 4, 8, 9, 10, and 18) concerned students' mastery of specific rules and procedures. However, the other two (1 and 18) dealt with higher-order cognitive processes: viz., Comprehension and Applications (Wilson, 1971). Of the six objectives rated lowest (2, 12, 13, 14, 17, and 19) four were geometric in orientation. It would appear, then, that both elementary and secondary teachers are of the opinion that geometry is not an essential component of the mathematics curriculum of the elementary school.

The last item in the Learning Outcomes section of the questionnaires concerned the grade levels at which courses in mathematics, academic or otherwise, should be required of all students.[1] As is indicated in Table 5, a large majority of both elementary and secondary teachers felt that students should be required to take mathematics through Grade 11. However, there was substantial disagreement between elementary and secondary teachers insofar as requiring Grade 12 students to take some kind of mathematics course.

CLASSROOM ORGANIZATION

Results from the questionnaires show that the average size of a mathematics class at the elementary level is 25.0; at the secondary level, it is 29.4. The greatest average class size, 30.6, is found at Grade 8. As is shown in Figure 1, class size increases from a low of 23 pupils at Grade 1 to a high point at Grade 8 before declining in Grade 10 and Grade 12.

TABLE 4

Importance[a] of Selected Objectives for Students Completing Elementary School

Topic	*Ranking*
1. Place value	2.8
2. Expanded notation	1.9
3. Order of operations	2.7
4. Compute with whole numbers	3.0
5. Find prime factors	2.2
6. Calculate GCF	2.1
7. Calculate LCM	2.2
8. Find equivalent fractions	2.7
9. Decimals to fractions, and reverse	2.7
10. Write decimals and fractions as percents	2.6
11. Solve equations	2.2
12. Construct an angle	1.7
13. Bisect an angle	1.7
14. Identify angles	1.9
15. Measure in metric units	2.4
16. Construct equations	2.1
17. Construct flow charts	1.6
18. Verify answers	2.6
19. Scale drawings	1.8
20. Use percents	2.3
21. Find perimeters	2.4

[a] 3 = essential; 2 = important, but not essential; 1 = optional.

TABLE 5

Teachers' Opinions Concerning the Grade Levels at Which Mathematics Should Be Compulsory

Grade Level	*% of Respondents Saying "Yes"*	
	Elementary	*Secondary*
8	99.8	99.6
9	99.4	98.8
10	97.6	96.2
11	84.3	77.8
12	73.1	47.7

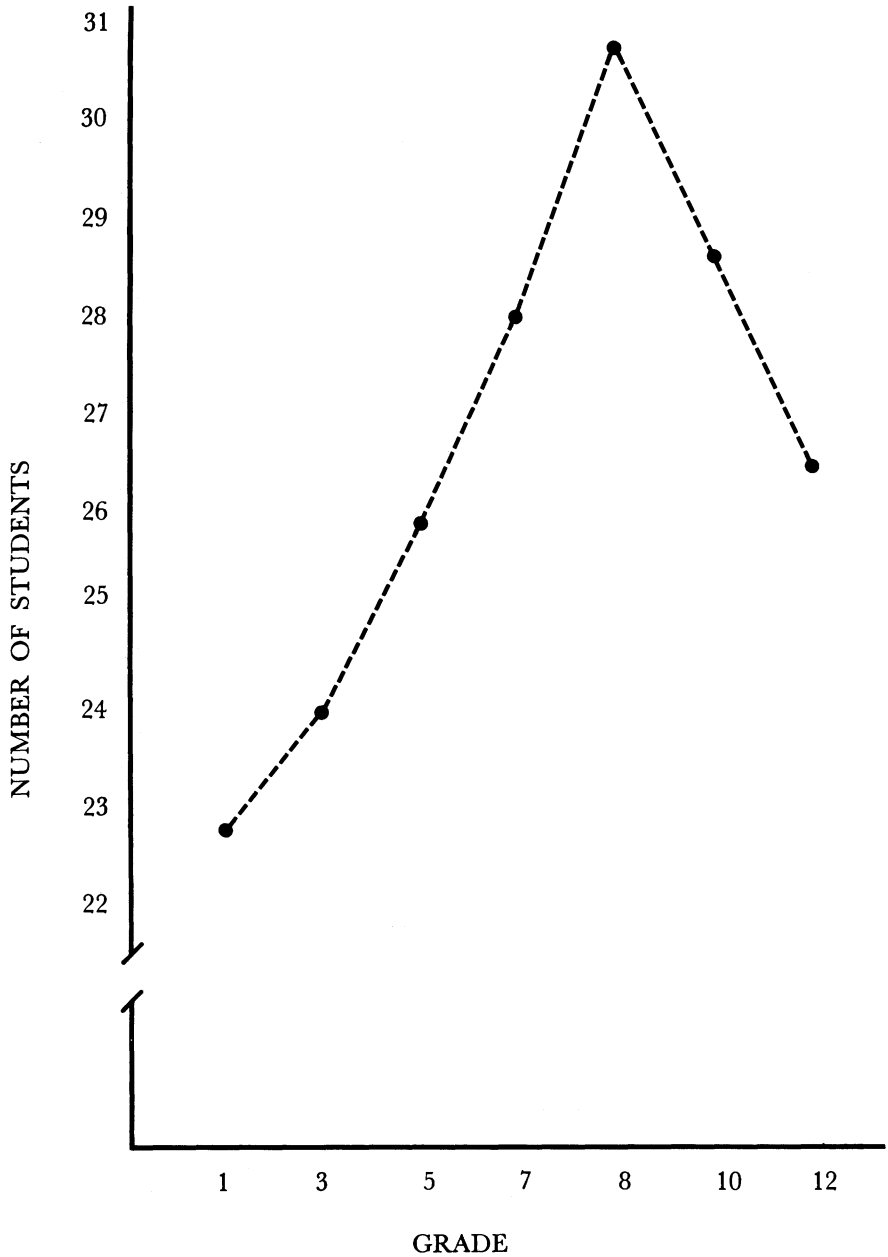

FIGURE 1

Average Class Size for Mathematics

Elementary teachers spend an average of 51 minutes per day teaching mathematics,[2] and an additional 38 minutes in lesson preparation and grading. Teachers of secondary mathematics, who tend to be subject-matter specialists and hence teach fewer subjects than elementary teachers, spend an average of 176 minutes per day teaching mathematics, 53 minutes in class preparation, and 38 minutes grading students' work.

The data in Table 6 show that the self-contained classroom is by far the most common teaching situation at all grade levels. However, about 20% of Grade 7 teachers indicated that there is a degree of departmentalization in their classes: i.e., different teachers for different subjects. Open area classes and team teaching have made some inroads at the primary level, but not at the higher grade levels.

TABLE 6

Description of Teaching Situation (Percent[a])

	1	*3*	*5*	*7*	*8*	*10*	*12*
Self-contained room	86.4	83.8	83.2	77.8	96.1	97.5	98.9
Team teaching	7.3	5.4	3.8	3.3	0.8	1.8	0.0
Open area	7.7	8.4	5.5	3.7	0.3	0.7	0.0
Shared workload[b]	2.6	5.0	8.6	20.9	(not asked)		
Other	3.4	7.0	6.7	6.9	4.7	1.5	0.0

[a] Respondents were permitted to select more than one alternative so the total of a given column may exceed 100%.

[b] One teacher teaches the mathematics, another language arts, etc. (elementary only).

A large proportion of teachers at all levels indicated that some form of ability grouping, partially individualized instruction, and total class instruction were used in their mathematics classes. The use of total class instruction tended to increase with grade level taught, while the other two decreased.

The most prevalent activities in elementary mathematics classrooms are individual work, teacher explanation, oral work, drill on number facts, and work on textbook exercises. At the secondary level they are individual work, teacher explanation, and work on textbook exercises. The use of activity centres and creative projects for the teaching of mathematics is very limited at both the elementary and secondary levels.

The overall picture presented by these results is that a considerable amount of time is spent preparing for and teaching mathematics classes, and that the teaching of mathematics is highly traditional in character. Combining the results from several items shows that the most frequently used teaching techniques are total class instruction and teacher explana-

tion. Among the most commonly used student activities are indivdual work and textbook exercises. In other words, and especially at the higher grade levels, classroom organization for the teaching of mathematics is much the same as it has always been.

CLASSROOM INSTRUCTION

Teachers were asked to rank five major strands according to the amount of time they spent on each in their mathematics classes. The rankings ranged from 1 (least time spent) to 5 (most time spent).

TABLE 7

Teachers' Rankings of Strands

	Elementary	*Secondary*
Drill on basic facts	3.7	(not asked)
Arithmetic computation	4.5	3.0
Problem-solving	3.5	3.8
Geometry	1.9	2.5
Metric measurement	2.4	2.1
Algebraic concepts	(not asked)	4.0

As is shown in Table 7, elementary teachers consider computation to be the most important strand they teach and geometry the least important. In fact, less time is spent teaching geometry than teaching metric measurement. At the secondary level, the most important strands are algebraic concepts and problem-solving.

On a related item, results showed that teachers are not making use of the metric system exclusively in their teaching of mathematics and other subjects. In other words, even though the changeover to the metric system in British Columbia has been proceeding for several years, and even though the Curriculum Guide for Mathematics (1978) states that all instruction in elementary and secondary school should be predominantly metric by 1978, many teachers have yet to make the necessary changes in their teaching.

In Table 8 are summarized the rankings given by teachers to various resources which they might use to help them plan their mathematics lessons. Each item was ranked on a scale from 1 (not useful) to 5 (very useful).

No item was ranked higher than 3.9, indicating that none of these resources was seen as being of great use by most teachers. Those ranked highest included the students' text, last year's preparation, and the teacher's edition of the student text. This last was seen as being much more useful by elementary teachers than by secondary teachers. Both

TABLE 8

Teachers' Opinions Regarding the Usefulness of Resources for Planning Lessons

Resource	*Elementary*	*Secondary*
Last year's preparation	3.3	3.5
Curriculum guide	2.9	2.9
BCTF lesson aids	2.2	1.8
Student's text	3.9	3.9
Teacher's guide	3.9	2.6
University courses	2.5	2.4
Supervisors	1.8	1.3
Purchased materials	3.0	2.8
Resource centre	2.6	1.8
Professional journals	2.3	2.3
Inservice activities	3.4	2.6
District specialists	1.9	1.7
Local curriculum guides	2.7	2.6

groups agreed that supervisors and district specialists were the least useful to them insofar as the planning of day-to-day lessons was concerned.

In ranking the importance of 16 factors purported to affect the success of mathematics instruction, elementary teachers gave high priority to eight factors: reduction of class size, reduction of total pupil load, greater release time for preparation, more manipulative materials, textbooks better suited to instructional needs, curriculum guides that outline content in specific terms, curriculum guides that offer more assistance in the instructional process, and more effective inservice training and professional development. Teachers of secondary mathematics gave high priority to four factors: reduction of class size, textbooks more suited to instructional needs, ability grouping of students for classes, and reduction of total pupil load.

Some obvious trends were discernible from the data collected concerning the frequency of use of selected audio-visual aids, materials, and methods for the teaching of mathematics. Both elementary and secondary teachers make extensive use of only one medium, the chalkboard, in presenting lessons. At the secondary level the overhead projector also enjoys relatively widespread use. Neither group would appear to be using television, films, or filmstrips to any significant degree in their teaching of mathematics.

All seven grade-level groups of teachers agreed that elementary students should not be permitted to use hand-held calculators, and that secondary students should be. Where students are permitted to use calculators, regardless of grade level, teachers feel that they should not be per-

mitted unrestricted use and they should not be permited to make use of them on tests. The main use that elementary teachers make of calculators is to show children how to use calculators. Secondary teachers use them to simplify computation so that concepts may be covered in more depth, and in order that many more examples of the concept may be shown.

Over 70% of secondary teachers indicated that their schools do not use computers for instructional purposes. Another 17% indicated that their schools use computers for instructional purposes but that they themselves do not use computers in their mathematics classes.

There was virtually unanimous agreement among secondary teachers that their students should be doing homework in mathematics. The majority of Grade 8 and Grade 10 teachers felt that students should spend no more than 30 minutes per day on mathematics homework. Among Grade 12 teachers, about 80% felt that students should spend between 30 and 60 minutes per day for mathematics homework.

USE OF TEXTBOOKS

Teachers would prefer to have textbooks which place more emphasis on skills practice than is present in the textbooks currently in use. In fact, exercises are judged to be a more important feature of textbooks than the presentation of concepts and principles. An overwhelming majority (94%) of teachers feel that the ministry of education should provide teachers with statements of minimal learning outcomes for each grade to help them in selecting textbooks and other learning materials.

Mathematics texts are used primarily as sources for exercises. They are used less often for reviewing concepts presented in class, and even less frequently for introducing new concepts. Teachers at all levels said that they do not want textbooks which place greater emphasis upon concepts and principles than upon skills and drill. They particularly want textbooks to provide material for drill and practice.

A majority of teachers at each level indicated that they do not require their students to read their mathematics textbooks to any great extent. At every level except Grade 7, more than two-thirds of the teachers said they expect their students to read no more than two pages out of every five. Part of the reason for this may be that several of the approved texts were judged to have too high a reading level for the students. This was true at both the elementary and the secondary levels. Very few texts were seen to have too low a reading level and those that were, with one exception, were textbooks designed to be used with students of lower ability.

Respondents were also asked to rate a number of features found in most teacher's editions of mathematics texts. The five most popular features were, in descending order, enrichment materials, lesson objectives, follow-up activities, suggestions for remedial work, and diagnostic tests. Features that were ranked lowest in importance were time allotments,

answers (either overprinted or at the end), and suggested discussion for the lessons. Teachers of secondary mathematics attached less importance to the value of having a teacher's edition than did elementary teachers.

On the whole teachers are satisfied with the textbooks which they are using, and many elementary teachers indicated that they were still using a text which is no longer on the prescribed list. Overall, about 80% of those responding stated that they were satisfied with their textbooks. Results ranged from a high of 92% approval at the Grade 12 level to a low of 68% at Grade 8.

A greater proportion of elementary than secondary teachers prefer to have several prescribed texts from which to choose. However, a clear majority of teachers at each level would prefer to have several texts from which to choose, rather than just one. Nevertheless, the multi-text approach, i.e., aproximately equal use of more than one text, has not gained widespread acceptance at any level, and certainly not at the secondary level. At least 75% of teachers surveyed said they use either one text exclusively or multiple texts with one being used predominantly. The latter approach was the most popular at all grade levels.

Most texts were seen by teachers as giving too little emphasis to computational skills and problem-solving. Of the approved texts, none was judged by more than 20% of the teachers as placing too much emphasis upon problem-solving. On the other hand, in almost every case at least 30% of the teachers felt that the text being rated contained too little emphasis on problem-solving. Similar results were found for the topic of computational skills.

DISCUSSION

The findings from this survey of teachers of mathematics in British Columbia closely resemble those reported by Price et al. (1977) in the U.S. The results indicate that, in spite of more than a decade of ferment and reform in mathematics education, the teaching of mathematics in B.C. appears to have changed very little. Moreover, the curricular objectives rated as most important by teachers are those concerned with "traditional" topics such as computational skills and algebraic manipulations. Topics which are newer to the curriculum, such as geometry in the elementary school, are seen as being of lesser importance.

NOTES

[1] Currently, mathematics is required of all students in B.C. through Grade 10.

[2] Approximately 5% of the elementary respondents indicated that they taught mathematics for more than 80 minutes per day, which would seem to indicate that they teach more than one mathematics class. For that reason, the amount of time spent teaching mathematics per day, as reported above, is not equal to the length of an average mathematics period. This latter figure would be somewhat less than 51 minutes.

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