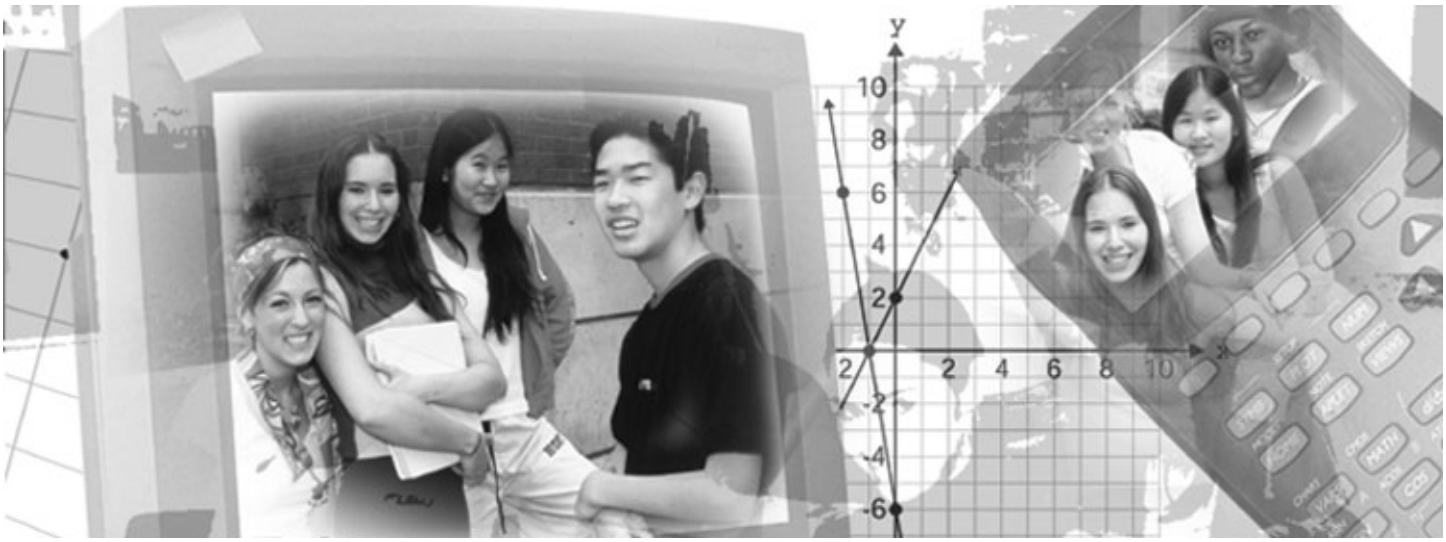
EQAO
Education
Quality and
Accountability
Office

The Grade 9 Assessment of Mathematics, 2002–2003

Report of Provincial Results



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Contents

EQAO
Information for Learning: Working Together to Improve Student Achievement

The goal of assessing and reporting is to ensure greater accountability in Ontario's public education system by giving parents, educators and students information that will help them improve student achievement and the quality of education. Ontario's large-scale assessment program is one important element of a culture of capacity building and learning improvement. EQAO measures student performance and contributes to positive educational change by

- providing objective and high-quality information on the academic achievement of students as measured against established standards;
- encouraging an external and system-wide dialogue about the results, which leads to strategies for improvement;
- providing contextual information that allows educators, parents and the public to interpret results in a responsible and constructive manner and
- augmenting the information that educators gather in order to identify the areas in which resources are needed most.

EQAO conducts a range of province-wide assessments. The Grade 9 Assessment of Mathematics has been in place for three years. It involves all students in Grade 9 academic and applied mathematics courses and is a valuable source of information on what these students have learned in mathematics.

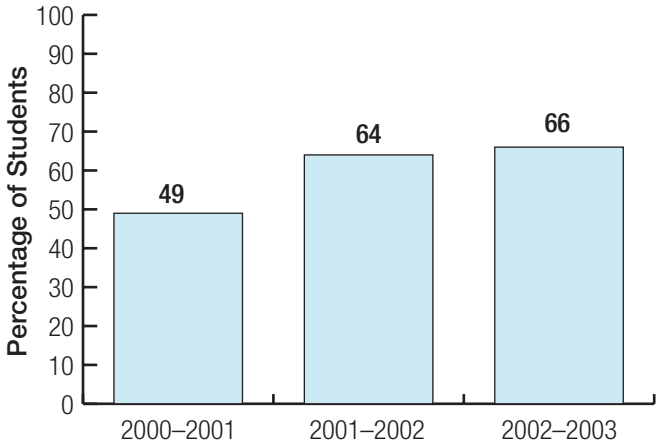
Results at a Glance

Data Comparison over Time

Overall Achievement: Level 3 and Above[1] (Method 1[2])

Academic

2000–2001 (# = 95 312)	2001–2002 (# = 99 094)	2002–2003 (# = 100 717)
49%	64%	66%

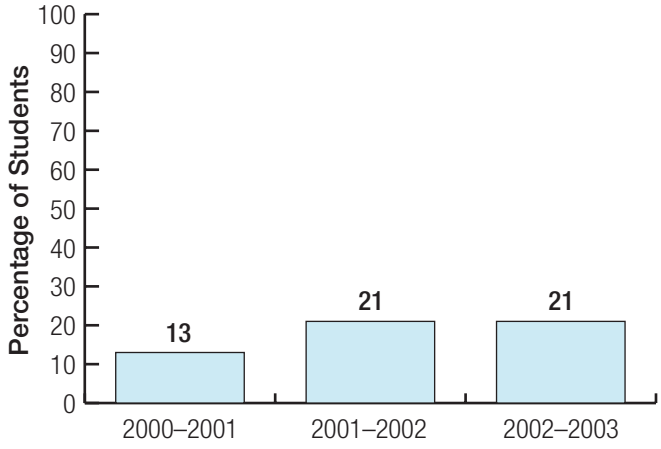


Observations

- 66% of students in the academic program achieved the provincial standard.
- Over the past three years, there has been a significant increase in the percentage of students in the academic program achieving the provincial standard.

Applied

2000–2001 (# = 41 708)	2001–2002 (# = 47 220)	2002–2003 (# = 48 426)
13%	21%	21%



Observations

- 21% of students in the applied program achieved the provincial standard.
- The achievement of students in the applied program has remained the same as last year.

Note: Throughout this report, whenever data do not add up to 100%, the difference is due to rounding.

[1] Percentages achieving Level 3 and above are reported here because *The Ontario Curriculum* sets Level 3 as the provincial standard.

[2] See page 10 for a description of Method 1.

Key Observations

Achievement Results

- Over the past three years, there has been a significant increase in the percentage of students in the academic program achieving the provincial standard.
- From the first to the second year of the assessment, there was an increase in the percentage of students in the applied program reaching the provincial standard; students' achievement in the applied program has remained the same over the past two years.
- In general, male students' attitudes are more positive toward mathematics; however, males and females in both the applied and the academic programs performed equally well on the assessment.
- The percentage of English as a second language and English literacy development (ESL/ELD) students at the provincial standard or above, in both the applied and the academic programs, has been the same for the past two years.
- The percentage of students with special needs reaching the provincial standard, in both the applied and the academic programs, is increasing.

Other Observations

- More students in the applied than in the academic program indicated they received no homework; more students in the applied program indicated that when they received homework, they usually spent no time on it.
- Students in the applied program indicated higher rates of absenteeism than students in the academic program.

Key Recommendations

EQAO recommends that

- each **school** study the assessment data and develop an initiative for its school improvement plan geared toward improving student performance, particularly at the applied level.
- **principals and teachers** continue to ensure that the instruction in mathematics classes, particularly in the applied program, is aligned with the philosophy, methodology and content of the curriculum.
- **school councils** continue to monitor student achievement and take an active role in school improvement.
- **school board** improvement teams, which include administrators, curriculum leaders, parents and teachers, as part of their ongoing improvement efforts, review historical student achievement and contextual data and identify areas for the continuous improvement of achievement in relation to the *Ontario Curriculum* standards for mathematics.
- **faculties of education** assist pre-service teachers to gain a thorough understanding of the mathematics curriculum's philosophy, methodology and content, as well as current assessment practices, including large-scale performance-based assessment, and the ways in which assessment assists instruction.
- the **Ontario College of Teachers,** through the Professional Learning Program providers, offer opportunities for professional development that focuses on the relationships among mathematics curriculum, teaching practices and assessment.
- the **Ministry of Education** work with EQAO to use the Grade 9 provincial assessment data accumulated over the past three years to inform the Expert Panel on Students at Risk (Numeracy) and curriculum review activities.

The Grade 9 Assessment of Mathematics, 2002–2003

Introduction

The purpose of EQAO is to promote greater accountability in the publicly funded education system in Ontario and to improve the quality of education in the province. In order to fulfill its mandate, EQAO conducts several province-wide assessments, among them the Grade 9 Assessment of Mathematics.

The Grade 9 Assessment of Mathematics measures how well students have met the expectations in *The Ontario Curriculum, Grades 9 and 10: Mathematics*. The assessment is based on the expectations in the Grade 9 curriculum for applied and academic mathematics courses.

Students in locally developed courses do not take part in this assessment. Locally developed courses are developed within school boards to meet educational needs that are not met by courses outlined in the provincial curriculum documents.

The results of these assessments provide individual, school, school board and provincial data on student achievement. Parents receive an Individual Student Report that gives information on their child's achievement on the assessment. Schools and school boards create their own reports, based on EQAO data, for distribution to parents and other stakeholders in the community. EQAO posts school board and school results on its Web site for access by the general public.

Applied and Academic Courses

In Grades 9 and 10, students choose between two types of courses: applied and academic. EQAO develops separate versions of the assessment for students in applied and academic courses. Since some of the expectations for applied and academic courses overlap, approximately 40% of the assessment items are common to both the applied and the academic versions.

Semestered and Full-Year Schools

Schools have the option of offering semestered courses or courses over the full year. EQAO develops separate versions of the assessment for administration in January and May/June.[3]

Development of the Assessment

The assessment was developed to serve the following purposes:

- to provide valid and reliable information about student achievement;
- to provide a broad window on students' knowledge and skills in mathematics and
- to contribute to student learning.

Teams of classroom teachers from across the province developed items for the assessment and, as part of the development process, tried out items in their classes.

Items for future assessments were pilot tested and field tested during the January and May/June administrations. At various stages, teachers provide feedback on the assessment items. EQAO used such feedback to revise the assessment materials for the administrations in January and May/June 2003.

[3] Some schools did not indicate whether students were enrolled in a semestered or a full-year course. As a result, there are students included in the total who are not counted as part of the first-semester, second-semester or full-year statistics.

The assessment was validated by educators with expertise in mathematics, in-depth knowledge of the mathematics expectations for Grade 9 (as outlined in *The Ontario Curriculum, Grades 9–10: Mathematics),* experience with equity issues, knowledge of the special needs of some students and technical expertise in the areas of assessment validity and reliability.

Content of the Assessment

The assessment comprised a multiple-choice component, a short-answer component and performance-based tasks.

Multiple-Choice Component

Students were asked to answer 24 questions during a 30-minute period. Each multiple-choice question was related to a single strand and a single category (see the strand and category definitions in Appendix A). The multiple-choice component allowed students to demonstrate their understanding of mathematical concepts without having to show their work or write responses.

Short-Answer Component

Students were asked to complete 10 items during a 30-minute period. Each short-answer item was related to a single strand and a single category. These items required students to think mathematically but required minimal written response.

Performance-Based Tasks

Students were asked to complete a total of six tasks. Each task was a collection of related questions based on one or two strands from the curriculum. Each task was scored for achievement across all four categories and the strands related to the task.

Additional Component

A sample of students completed an additional 30-minute component that was scored but did not count toward their results. This component included items that were used to establish comparability between the assessments administered in January and May/June and among the 2000–2001, 2001–2002 and 2002–2003 assessments. It also included items that were being pilot tested or field tested for future use.

Participation in the Assessment

All Grade 9 students who are enrolled in an applied or academic mathematics course are expected to participate in this annual assessment. An accommodation policy is in place to support students with special needs. Special provisions are permitted for students who lack proficiency in English.

Principals and teachers are responsible for accommodating students with special needs identified in an Individual Education Plan so that these students can take part in the assessment. The list of permitted accommodations appears on the CD-ROM used for training to administer the assessment; the list also appears on EQAO's Web site, www.eqao.com.

Principals and teachers are able to make special provisions for students enrolled in ESL/ELD programs. The list of permitted special provisions appears on the CD-ROM.

The principal may consider exempting any student who, despite the permitted accommodations and special provisions, would not be able to provide evidence of learning.

Decisions about accommodations, special provisions and exemptions must be made by the principal on an individual basis and in consultation with the student, his or her parents or guardians and appropriate staff. Parental consent is required for an exemption.

Administration of the Assessment

The assessment was administered January 8–21, 2003, to students in first-semester mathematics courses and May 26–June 13, 2003, to students in second-semester and full-year courses.

Principals had the option of administering the assessment over two or four days. An additional day was required in school boards selected to complete the additional component.

Marking the Assessment

Teachers trained in marking scored the short-answer and performance-based items, using a scoring scale that had three to six possible codes for each item. The multiple-choice items were machine-scored. The multiple-choice scores were combined with the short-answer and performance-based scores to produce category, strand and overall scores. With the aid of a statistical procedure that takes into account the degree of difficulty of each test item and the input of the markers, the category, strand and overall scores were then mapped onto EQAO's reporting scale.

This scoring procedure results in precise scoring and allows for the comparability of the category, strand and overall results from administration to administration and from year to year. For further information, visit the EQAO Web site, www.eqao.com.

Reporting Results

Achievement results are reported in two ways: Method 1 and Method 2.

Method 1

Data for all students in the grade are reported. Method 1 expresses the number of students in each reporting category as a percentage of all students in the grade (i.e., students at the four levels of achievement and those in the exempted, no data, NEIS and Below Level 1 categories described on page 11).

Method 2

An alternative way of presenting the data, Method 2 expresses the distribution of results as a percentage of those students who took part in the assessment (i.e., students at the four levels of achievement and those in the NEIS and Below Level 1 categories described on page 11). Students in the exempted and no data categories are excluded.

Achievement Levels

EQAO reports on student achievement in Grade 9 mathematics using a four-level scale. This four-level scale is aligned with the scale used in *The Ontario Curriculum, Grades 9 and 10: Mathematics* and the Provincial Report Card, Grades 9–12.

Overall Achievement

The overall achievement level provides a general picture of the student's achievement of the curriculum expectations in mathematics. The overall level reflects achievement across all of the categories and strands.

Note: Due to rounding, percentages in the achievement tables may not total 100.

Strand and Category Achievement

The strand and category achievement levels provide more detailed information about the student's knowledge and skills in specific areas of the mathematics curriculum. The strands and categories are based on those in *The Ontario Curriculum*. The four strands provide information on the student's strengths and weaknesses in the major content areas of mathematics (number sense and algebra, relationships, measurement and geometry, analytic geometry). The four categories (knowledge and understanding; thinking, inquiry and problem solving; application; and communication) provide information on strengths and weaknesses in specific knowledge and skill areas that apply to all four strands.

Provincial Standard

The Ontario Curriculum establishes Level 3 as the provincial standard. As stated in the curriculum, this is a high level of achievement, and students who are achieving this level or above can be confident that they are "well prepared for work in the next grade or the next course."

The Ontario Curriculum identifies Level 1 as a "passable level of achievement."

Exempted or No Data

These designations include students who were formally exempted from participation in the assessment and students from whom EQAO did not receive completed assessment booklets.

Not Enough Information to Score (NEIS)

This designation represents student work that could not be scored, because large sections were missing or illegible.

Below Level 1

Below Level 1 identifies insufficient achievement of the curriculum expectations.

Level 1

Level 1 identifies a passable level of achievement. Achievement is below the provincial standard.

Level 2

Level 2 identifies a moderate level of achievement. Achievement is below but approaching the provincial standard.

Level 3

Level 3 identifies a high level of achievement. Achievement is at the provincial standard.

Level 4

Level 4 identifies a very high to outstanding level of achievement. Achievement is above the provincial standard.

Collection of Questionnaire Data

During both the January 2003 and the May/June 2003 administrations, teachers and students of applied and academic courses were asked to complete detailed, anonymous questionnaires. Their responses were tabulated. Except in cases where a student's or teacher's privacy would be compromised, EQAO tabulates student questionnaire data for the province as a whole and by school and school board, and it tabulates teacher questionnaire data for the province as a whole and by school board. The provincial questionnaire data in this report, together with the wide range of contextual data that schools and school boards collect locally, should be referred to when interpreting the achievement results.

Profile of Students in Grade 9 Mathematics — Academic[4]

Number of Students

Program				
First Semester	Second Semester	Full Year	No Response	Total
42 322	40 310	18 082	3	100 717

Gender	Percentage
Female	51%
Male	48%
No Response	1%

Place of Birth	Percentage
Inside Canada	80%
Outside Canada	19%
No Response	<1%

Year of Birth	Percentage
1986 or Before	1%
1987	4%
1988	94%
1989 or After	1%
No Response	<1%

Language(s) Spoken at Home	Percentage
Only English	63%
Mostly English	17%
English as Often as Another Language	11%
Mostly Another Language	7%
Only Another Language	3%
No Response	<1%

Observations

- 82% of academic students were in a semestered program; 18% were in a full-year program.
- 19% of students in the academic program were born outside Canada.
- 80% of students in the academic program spoke only or mostly English at home.

[4] These data derive from the Grade 9 Class Tracking Sheet, the Grade 9 Student Information Form and the Grade 9 Student Questionnaire.

Accommodations and Special Provisions — Academic

	Percentage
Students Who Received Accommodations and Special Provisions (# = 105)	<1%
Students Who Received Accommodations (# = 1952)	2%
Students Who Received Special Provisions (# = 1601)	2%
Students Who Received No Accommodations or Special Provisions (# = 96 061)	95%
Students for Whom Information Is Missing (# = 494)	<1%

Note: The above table does not include exempted students.

Participation — Academic

	Eligible Population	Percentage No Data	Percentage Exempted	Percentage Fully Participated
All Academic Students	100 717	2%	<1%	97%
Program				
Semester 1	42 322	1%	1%	98%
Semester 2	40 310	2%	<1%	98%
Full year	18 082	5%	<1%	95%
Gender				
Female	51 352	2%	<1%	98%
Male	48 750	2%	1%	97%
Student Status				
ESL/ELD	3045	2%	11%	87%
Special Needs	4181	2%	2%	96%

Observations

- 3% of all students in the academic program had ESL/ELD designation.
- 4% of all students in the academic program had been identified as having special needs.
- The percentages of ESL/ELD and special needs students exempted were about the same as last year's.

Overall Achievement — Academic

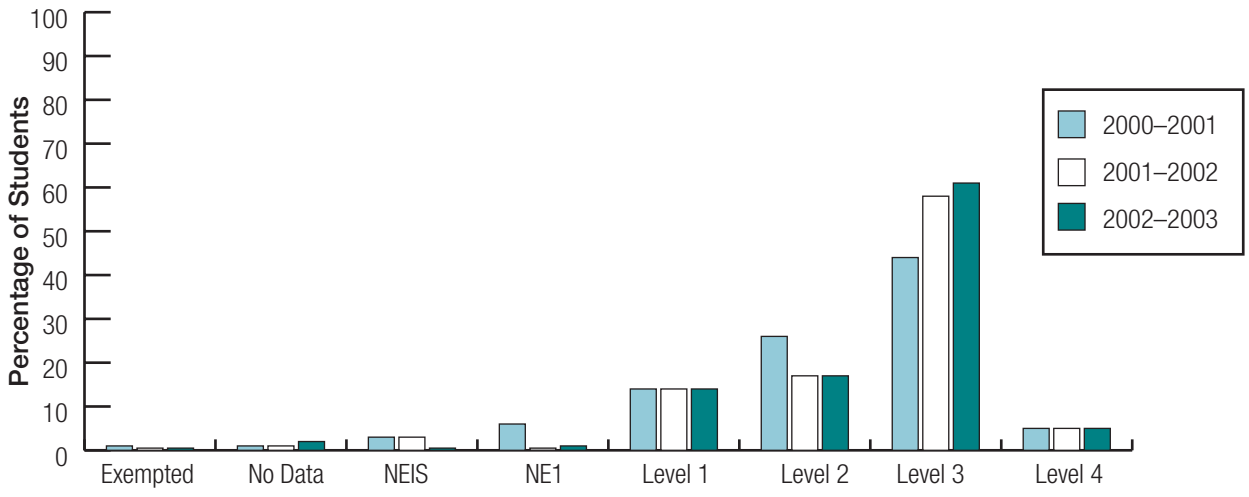
	Exempted	No Data	NEIS	Below Level 1	Level 1	Level 2	Level 3	Level 4
Method 1[5] (# = 100 717)	<1%	2%	<1%	1%	14%	17%	61%	5%
Method 2 (# = 98 147)	n/a	n/a	<1%	1%	15%	17%	62%	5%

Observation

- About two-thirds of students in the academic program achieved the provincial standard.

Year-to-Year Comparisons — Academic

	2000–2001 (# = 95 312)	2001–2002 (# = 99 094)	2002–2003 (# = 100 717)
Exempted	1%	<1%	<1%
No Data	1%	1%	2%
Not Enough Information to Score (NEIS)	3%	3%	<1%
Below Level 1	6%	<1%	1%
Level 1	14%	14%	14%
Level 2	26%	17%	17%
Level 3	44%	58%	61%
Level 4	5%	5%	5%



[5] See page 10 for descriptions of Methods 1 and 2.

Observations

- 66% of students in the academic program achieved the provincial standard.
- Over the past three years, there has been a significant increase in the percentage of students in the academic program achieving the provincial standard (49% in 2000–2001, 64% in 2001–2002 and 66% in 2002–2003).[6]

By Program — Academic

	Exempted	No Data	NEIS	Below Level 1	Level 1	Level 2	Level 3	Level 4
Semester 1 (# = 42 322)								
Method 1	1%	1%	<1%	1%	14%	18%	61%	5%
Semester 2 (# = 40 310)								
Method 1	<1%	2%	<1%	<1%	14%	17%	61%	4%
Full Year (# = 18 082)								
Method 1	<1%	5%	<1%	1%	14%	15%	59%	6%

Observation

- The percentage of academic students at or above the provincial standard was about the same for students in semestered and full-year programs.

By Gender — Academic

	Exempted	No Data	NEIS	Below Level 1	Level 1	Level 2	Level 3	Level 4
Female (# = 51 352)								
Method 1	<1%	2%	<1%	<1%	14%	17%	61%	5%
Male (# = 48 750)								
Method 1	1%	2%	<1%	1%	14%	17%	61%	5%

Observation

- Females and males performed equally well; this has remained consistent over the past three years.

[6] Any differences between these percentages and those obtained by combining the percentages at Levels 3 and 4 in the preceding table are attributable to rounding.

By Student Status (ESL/ELD) — Academic

	Exempted	No Data	NEIS	Below Level 1	Level 1	Level 2	Level 3	Level 4
Non-ESL/ELD (# = 97 672)								
Method 1	<1%	2%	<1%	<1%	14%	17%	61%	5%
ESL/ELD (# = 3045)								
Method 1	11%	2%	1%	3%	23%	14%	41%	4%

Observations

- 45% of ESL/ELD students in the academic program achieved the provincial standard.
- The performance of ESL/ELD students in the academic program has been relatively constant over the past two years.

By Special Need (Excluding Gifted) — Academic

	Exempted	No Data	NEIS	Below Level 1	Level 1	Level 2	Level 3	Level 4
Special Needs (# = 4181)								
Method 1	2%	2%	1%	1%	24%	20%	47%	3%
All Other Students (# = 96 536)								
Method 1	<1%	2%	<1%	<1%	14%	17%	61%	5%

Observations

- 50% of academic students with special needs achieved the provincial standard.
- There was a 7% increase over last year in the percentage of students with special needs at the provincial standard or above.

Overall Achievement by Category — Academic

See Appendix A for definitions of the categories.

Knowledge and Skill Categories	Exempted	No Data	NEIS	Below Level 1	Level 1	Level 2	Level 3	Level 4
Knowledge/Understanding								
Method 1 (# = 100 717)	<1%	2%	1%	<1%	14%	13%	67%	3%
Method 2 (# = 98 142)	n/a	n/a	1%	<1%	14%	13%	69%	3%
Application								
Method 1 (# = 100 717)	<1%	2%	1%	3%	13%	11%	60%	9%
Method 2 (# = 98 131)	n/a	n/a	1%	3%	13%	11%	62%	9%
Thinking/Inquiry/Problem Solving								
Method 1 (# = 100 717)	<1%	2%	2%	<1%	28%	14%	45%	8%
Method 2 (# = 98 129)	n/a	n/a	2%	<1%	29%	15%	46%	8%
Communication								
Method 1 (# = 100 717)	<1%	2%	1%	<1%	5%	36%	55%	<1%
Method 2 (# = 98 129)	n/a	n/a	1%	<1%	5%	37%	56%	<1%

Observations

- About 70% of students in the academic program achieved the provincial standard for each of knowledge and understanding, and application.
- A little more than half the students in the academic program achieved the provincial standard for each of thinking, inquiry and problem solving; and communication.

Overall Achievement by Strand — Academic

See Appendix A for definitions of the strands.

Knowledge and Skill Strands	Exempted	No Data	NEIS	Below Level 1	Level 1	Level 2	Level 3	Level 4
Number Sense and Algebra								
Method 1 (# = 100 717)	<1%	2%	1%	<1%	12%	19%	63%	3%
Method 2 (# = 98 130)	n/a	n/a	1%	<1%	12%	19%	65%	3%
Relationships								
Method 1 (# = 100 717)	<1%	2%	1%	<1%	9%	21%	53%	13%
Method 2 (# = 98 127)	n/a	n/a	1%	<1%	10%	21%	54%	14%
Analytic Geometry								
Method 1 (# = 100 717)	<1%	2%	1%	<1%	12%	30%	53%	1%
Method 2 (# = 98 132)	n/a	n/a	1%	<1%	12%	31%	55%	1%
Measurement and Geometry								
Method 1 (# = 100 717)	<1%	2%	1%	2%	14%	17%	62%	1%
Method 2 (# = 98 114)	n/a	n/a	1%	2%	14%	18%	64%	1%

Observations

- About two-thirds of academic students achieved the provincial standard for each of number sense and algebra, and relationships.
- 63% of academic students achieved the provincial standard for measurement and geometry.
- A little more than half the academic students achieved the provincial standard for analytic geometry.
- There were more academic students at Level 4 in the relationships strand than in the other strands.

Students' Learning Environment — Academic

All Students	Completed Questionnaires	Response Rate
100 717	97 029	96%

Observation

- In Ontario, there were more than twice as many Grade 9 students in the academic program as there were in the applied program.

Student Attendance — Academic

Percentage of students indicating that in the past month they have been absent from mathematics class	All (# = 97 029)	Females (# = 49 886)	Males (# = 47 071)
never.	30%	26%	35%
1 or 2 times.	45%	46%	43%
3 or 4 times.	16%	18%	14%
5 or more times.	9%	9%	8%

Observation

- Female academic students indicated that they had been absent from class more often than their male counterparts.

Student Mobility — Academic

Percentage of students indicating that they have attended the following number of elementary schools:	All (# = 97 029)	Females (# = 49 886)	Males (# = 47 071)
1 School	34%	33%	35%
2 Schools	36%	37%	36%
3 Schools	17%	17%	17%
4 Schools	7%	7%	7%
5 or More Schools	5%	5%	5%

Observation

- 12% of academic students indicated that they had attended four or more elementary schools; one and a half times as many students in the applied program reported this.

Student Computer and Calculator Use — Academic

Percentage of students indicating that	All (# = 97 029)	Females (# = 49 886)	Males (# = 47 071)
they have a computer at home that they use for school work.	96%	96%	95%
they have a scientific calculator at home that they use for school work.	89%	91%	88%
they have a graphing calculator at home that they use for school work.	6%	5%	7%

Observation

- 96% of students in the academic program indicated that they had computers at home that they used for school work.

Homework — Academic

Percentage of students indicating the following about time spent on mathematics homework on any given day:	All (# = 97 029)	Females (# = 49 886)	Males (# = 47 071)
I usually don't have any mathematics homework.	3%	3%	4%
I have mathematics homework, but I usually spend no time on it.	10%	7%	13%
I usually spend 30 minutes or less on mathematics homework.	38%	35%	41%
I usually spend between 31 and 45 minutes on mathematics homework.	35%	40%	31%
I usually spend more than 45 minutes on mathematics homework.	13%	15%	11%

Observations

- 96% of students in the academic program indicated that they were given mathematics homework.
- One in 10 students indicated that they usually spent no time on mathematics homework.
- In the academic program, a substantially larger percentage of females (55%) than males (42%) indicated that they spent more than 30 minutes on mathematics homework.

Student Attitudes Toward Mathematics — Academic

Percentage of students who strongly agree or agree with the following statements:	All (# = 97 029)	Females (# = 49 886)	Males (# = 47 071)
I like mathematics.	41%	36%	46%
I am good at mathematics.	44%	38%	51%
I understand most of the mathematics I am taught.	58%	53%	63%
The mathematics I learn now is very useful for everyday life.	30%	27%	34%
I need to keep taking mathematics for the kind of job I want after I leave school.	57%	54%	60%
Mathematics is boring.	32%	31%	31%
Mathematics is an easy subject.	27%	21%	32%

Observation

- A substantially higher percentage of males than females in the academic program reported each of the following: that they like mathematics, that they are good at mathematics, that they understand most of the mathematics they are taught, and that they think mathematics is an easy subject.

Teachers' Professional Learning Environment — Academic[7]

Note: Each teacher had to complete only one questionnaire, so teacher responses are based on one class only. Teachers who taught applied and academic classes chose one class and therefore one program.

School Resources

Percentage of teachers indicating that their Grade 9 mathematics students have access to the following items at school:	(# = 2449)				
	Never or Hardly Ever	A Few Times During the Course	A Few Times a Month	A Few Times a Week	Daily
Computers	27%	33%	10%	6%	22%
Graphing Calculators	4%	36%	27%	10%	20%

Observations

- 60% of the teachers who chose to report on academic indicated that their students had access to computers at school only a few times during the course, or never or hardly ever.
- 40% of the teachers who chose to report on academic indicated that their students have access to graphing calculators only a few times during the course, or never or hardly ever.

Teaching Practices

Percentage of teachers indicating that their Grade 9 mathematics students	Never or Hardly Ever	A Few Times During the Course	A Few Times a Month	A Few Times a Week	Daily
use concrete materials to investigate and gain an understanding of new concepts (# = 2449)	12%	44%	29%	10%	3%
use graphing calculators to explore and investigate mathematical ideas and relationships (# = 2449)	10%	56%	24%	6%	1%
use dynamic geometry software (e.g., The Geometer's Sketchpad, Cabri) (# = 2449)	45%	45%	6%	1%	1%

Observations

- 86% of the teachers who chose to report on academic indicated that their students used concrete materials to investigate and gain an understanding of new concepts at least a few times during the course.
- 87% of the teachers who chose to report on academic indicated that their students used graphing calculators to explore and investigate mathematical ideas and relationships at least a few times during the course.
- Although the curriculum requires students to demonstrate achievement of certain expectations using dynamic geometry software, 45% of the teachers who chose to report on academic indicated that they never or hardly ever used the software.

[7] Data in the following tables derive from the Grade 9 Teacher Questionnaire.

Percentage of teachers indicating percentages of course time they spend teaching the following mathematics strands:	(# = 2449)				
	1–20%	21–40%	41–60%	61–80%	81–100%
Number Sense and Algebra	13%	66%	14%	3%	1%
Relationships	12%	67%	16%	2%	1%
Analytic Geometry	29%	61%	6%	1%	<1%
Measurement and Geometry	56%	39%	2%	1%	<1%

Percentage of teachers indicating that their Grade 9 mathematics students engage in activities related to the following achievement categories:	(# = 2449)				
	Never or Hardly Ever	A Few Times During the Course	A Few Times a Month	A Few Times a Week	Daily
Knowledge/Understanding	<1%	2%	7%	17%	73%
Problem Solving	<1%	5%	22%	40%	31%
Communication	<1%	5%	19%	33%	40%
Application	<1%	3%	13%	37%	44%

Teachers' Experience and Background

Percentage of teachers indicating that they have been teaching	(# = 2449)		
	5 Years or Less	6–10 Years	11 Years or More
mathematics at the secondary level	43%	18%	36%
Grade 9 mathematics	60%	16%	22%

Observation

- Three-fifths of the teachers who chose to report on academic indicated that they had experience teaching Grade 9 mathematics of five years or less.

Percentage of teachers indicating that while studying to obtain their bachelor's degree (or equivalent), their	(# = 2449)
major area of study was	
mathematics.	42%
a mathematics-related subject.	33%
other.	21%
minor area of study was	
mathematics.	23%
a mathematics-related subject.	44%
other.	29%

Observation

- 75% of the teachers who chose to report on academic indicated that their major area of study was mathematics or a mathematics-related subject.

Percentage of teachers indicating that they have completed or are presently working toward the following:	(# = 2449)
Additional Basic Qualifications in Mathematics	35%
Three-Session Qualifications in Mathematics — Intermediate and Senior Education	10%
Honours Specialist Qualifications in Mathematics	28%

Profile of Students in Grade 9 Mathematics — Applied[8]

Number of Students

Program				
First Semester	Second Semester	Full Year	No Response	Total
21 032	20 927	6464	3	48 426

Gender	Percentage
Female	44%
Male	55%
No Response	1%

Place of Birth	Percentage
Inside Canada	83%
Outside Canada	16%
No Response	1%

Year of Birth	Percentage
1986 or Before	8%
1987	23%
1988	68%
1989 or After	1%
No Response	<1%

Language(s) Spoken at Home	Percentage
Only English	70%
Mostly English	14%
English as Often as Another Language	9%
Mostly Another Language	5%
Only Another Language	2%
No Response	<1%

Observations

- 87% of students in the applied program were in a semestered program; 13% were in a full-year program.
- There were more males than females in the applied mathematics program.
- Many students in the applied program were older than the average age of students in their cohort.
- 16% of students in the applied program were born outside Canada.
- 84% of students in the applied program spoke only or mostly English at home.

[8] These data derive from the EQAO Grade 9 Class Tracking Sheet, the Grade 9 Student Information Form and the Grade 9 Student Questionnaire.

Accommodations and Special Provisions — Applied

	Percentage
Students Who Received Accommodations and Special Provisions (# = 230)	<1%
Students Who Received Accommodations (# = 8121)	17%
Students Who Received Special Provisions (# = 1106)	2%
Students Who Received No Accommodations or Special Provisions (# = 37 591)	78%
Students for Whom Information Is Missing (# = 358)	1%

Note: The above table does not include exempted students.

Participation — Applied

	Eligible Population	Percentage No Data	Percentage Exempted	Percentage Fully Participated
All Applied Students	48 426	8%	2%	90%
Program				
Semester 1	21 032	6%	2%	92%
Semester 2	20 927	8%	2%	90%
Full year	6464	13%	2%	85%
Gender				
Female	21 387	7%	2%	90%
Male	26 625	7%	2%	91%
Student Status				
ESL/ELD	2236	6%	15%	79%
Special Needs	11 959	6%	4%	89%

Observations

- 5% of all students in the applied program had ESL/ELD designation.
- 25% of all students in the applied program had been identified as having special needs.
- The percentage of ESL/ELD students exempted has decreased from 23% last year to 15% this year.
- The percentage of special needs students exempted has remained about the same as last year.
- 13% of students in the full-year applied program provided no data.

Overall Achievement — Applied

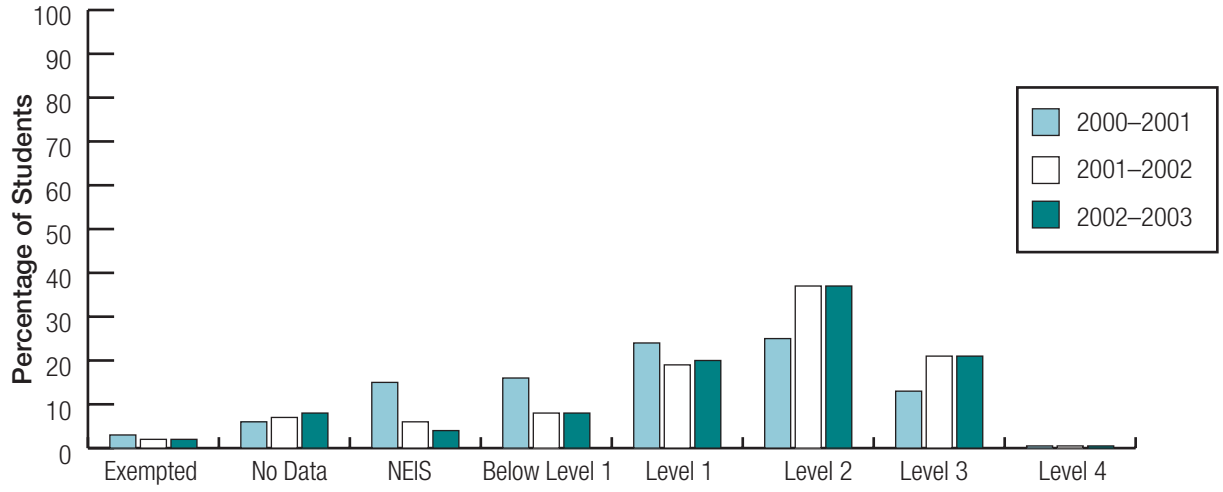
	Exempted	No Data	NEIS[9]	Below Level 1	Level 1	Level 2	Level 3	Level 4
Method 1 (# = 48 426)	2%	8%	4%	8%	20%	37%	21%	<1%
Method 2 (# = 43 631)	n/a	n/a	4%	9%	22%	41%	23%	<1%

Observation

- 21% of students in the applied program achieved the provincial standard.

Year-to-Year Comparisons — Applied

	2000–2001 (# = 41 708)	2001–2002 (# = 47 220)	2002–2003 (# = 48 426)
Exempted	3%	2%	2%
No Data	6%	7%	8%
Not Enough Information to Score (NEIS)	15%	6%	4%
Below Level 1	16%	8%	8%
Level 1	24%	19%	20%
Level 2	25%	37%	37%
Level 3	13%	21%	21%
Level 4	<1%	<1%	<1%



[9] Not enough information to score (see description on page 11).

Observations

- 21% of students in the applied program achieved the provincial standard.
- The achievement of students in the applied program has remained the same as last year.

By Program — Applied

	Exempted	No Data	NEIS	Below Level 1	Level 1	Level 2	Level 3	Level 4
Semester 1 (# = 21 032)								
Method 1	2%	6%	4%	9%	19%	38%	21%	<1%
Semester 2 (# = 20 927)								
Method 1	2%	8%	4%	8%	21%	37%	21%	<1%
Full Year (# = 6464)								
Method 1	2%	13%	4%	9%	20%	33%	19%	<1%

Observation

- The percentage of applied students at or above the provincial standard was about the same for students in semestered and full-year programs.

By Gender — Applied

	Exempted	No Data	NEIS	Below Level 1	Level 1	Level 2	Level 3	Level 4
Female (# = 21 387)								
Method 1	2%	7%	3%	8%	21%	38%	21%	<1%
Male (# = 26 625)								
Method 1	2%	7%	5%	9%	19%	36%	21%	<1%

Observation

- Females and males performed equally well; this has remained consistent over the past three years.

By Student Status (ESL/ELD) — Applied

	Exempted	No Data	NEIS	Below Level 1	Level 1	Level 2	Level 3	Level 4
Non-ESL/ELD (# = 46 190)								
Method 1	1%	8%	4%	8%	20%	38%	21%	<1%
ESL/ELD (# = 2236)								
Method 1	15%	6%	6%	21%	20%	22%	9%	<1%

Observations

- 9% of ESL/ELD students in the applied program achieved the provincial standard.
- The percentage of ESL/ELD students exempted dropped from 23% last year to 15% this year; the percentage of ESL/ELD students at the provincial standard or above has remained the same over the past two years.

By Special Need (Excluding Gifted) — Applied

	Exempted	No Data	NEIS	Below Level 1	Level 1	Level 2	Level 3	Level 4
Special Needs (# = 11 959)								
Method 1	4%	6%	4%	13%	24%	34%	15%	<1%
All Other Students (# = 36 467)								
Method 1	1%	8%	4%	7%	19%	38%	23%	<1%

Observations

- 15% of applied students with special needs achieved the provincial standard.
- The percentage of students with special needs reaching the provincial standard has increased steadily (9% in 2000–2001, 13% in 2001–2002 and 15% in 2002–2003).

Overall Achievement by Category — Applied

See Appendix A for definitions of the categories.

Knowledge and Skill Categories	Exempted	No Data	NEIS	Below Level 1	Level 1	Level 2	Level 3	Level 4
Knowledge/Understanding								
Method 1 (# = 48 426)	2%	8%	6%	8%	19%	33%	24%	<1%
Method 2 (# = 43 617)	n/a	n/a	7%	9%	21%	36%	27%	<1%
Application								
Method 1 (# = 48 426)	2%	8%	7%	21%	19%	27%	14%	1%
Method 2 (# = 43 561)	n/a	n/a	8%	24%	21%	30%	16%	1%
Thinking/Inquiry/Problem Solving								
Method 1 (# = 48 426)	2%	8%	8%	2%	35%	25%	19%	<1%
Method 2 (# = 43 523)	n/a	n/a	9%	2%	39%	28%	21%	<1%
Communication								
Method 1 (# = 48 426)	2%	8%	7%	5%	13%	54%	12%	<1%
Method 2 (# = 43 543)	n/a	n/a	7%	5%	14%	60%	13%	<1%

Observations

- Almost one-quarter of students in the applied program achieved the provincial standard for knowledge and understanding.
- Almost one-fifth of students in the applied program achieved the provincial standard for thinking, inquiry and problem solving.
- 15% of students in the applied program achieved the provincial standard for application, and 12% for communication.

Overall Achievement by Strand — Applied

See Appendix A for definitions of the strands.

Knowledge and Skill Strands	Exempted	No Data	NEIS	Below Level 1	Level 1	Level 2	Level 3	Level 4
Number Sense and Algebra								
Method 1 (# = 48 426)	2%	8%	7%	16%	12%	33%	23%	<1%
Method 2 (# = 43 542)	n/a	n/a	8%	17%	13%	37%	25%	<1%
Relationships								
Method 1 (# = 48 426)	2%	8%	7%	2%	18%	46%	17%	<1%
Method 2 (# = 43 558)	n/a	n/a	8%	2%	20%	52%	19%	<1%
Analytic Geometry								
Method 1 (# = 48 426)	2%	8%	6%	5%	22%	35%	22%	<1%
Method 2 (# = 43 553)	n/a	n/a	6%	5%	25%	39%	24%	<1%
Measurement and Geometry								
Method 1 (# = 48 426)	2%	8%	11%	10%	15%	36%	17%	<1%
Method 2 (# = 43 472)	n/a	n/a	13%	11%	17%	40%	19%	<1%

Observations

- Almost one-quarter of students achieved the provincial standard for each of number sense and algebra, and analytic geometry.
- 17% of students in the applied program achieved the provincial standard for each of relationships, and measurement and geometry.

Students' Learning Environment — Applied

All Students	Completed Questionnaires	Response Rate
48 426	42 682	88%

Observation

- In Ontario, students in the applied program numbered fewer than half those in the academic program.

Student Attendance — Applied

Percentage of students indicating that in the past month they have been absent from mathematics class	All (# = 42 682)	Females (# = 19 113)	Males (# = 23 498)
never.	21%	17%	24%
1 or 2 times.	38%	37%	38%
3 or 4 times.	21%	23%	19%
5 or more times.	19%	21%	17%

Observations

- 19% of students in the applied program indicated that they had been absent five or more times in the past month, compared to 9% of students in the academic program.
- Female applied students indicated that they had been absent from class more often than their male counterparts.

Student Mobility — Applied

Percentage of students indicating that they have attended the following number of elementary schools:	All (# = 42 682)	Females (# = 19 113)	Males (# = 23 498)
1 School	32%	30%	33%
2 Schools	32%	32%	32%
3 Schools	17%	18%	16%
4 Schools	9%	9%	8%
5 or More Schools	9%	9%	8%

Observation

- 18% of applied students indicated that they had attended four or more elementary schools, compared to 12% of students in the academic program.

Student Computer and Calculator Use — Applied

Percentage of students indicating that	All (# = 42 682)	Females (# = 19 113)	Males (# = 23 498)
they have a computer at home that they use for school work.	83%	84%	83%
they have a scientific calculator at home that they use for school work.	75%	77%	73%
they have a graphing calculator at home that they use for school work.	5%	4%	6%

Observation

- 83% of students in the applied program indicated that they had computers at home that they used for school work, an increase of 3% from last year.

Homework — Applied

Percentage of students indicating the following about time spent on mathematics homework on any given day:	All (# = 42 682)	Females (# = 19 113)	Males (# = 23 498)
I usually don't have any mathematics homework.	17%	16%	18%
I have mathematics homework, but I usually spend no time on it.	19%	16%	21%
I usually spend 30 minutes or less on mathematics homework.	40%	41%	39%
I usually spend between 31 and 45 minutes on mathematics homework.	18%	21%	15%
I usually spend more than 45 minutes on mathematics homework.	5%	6%	5%

Observations

- 82% of students in the applied program indicated that they were given homework.
- Almost one in five students indicated that they usually spent no time doing homework, which is nearly double the percentage (10%) reported by academic students.
- In the applied program, more female (27%) than male students (20%) indicated that they spent more than 30 minutes on mathematics homework.
- A larger percentage of students in the applied program (17%) than in the academic program (3%) reported that they received no homework.

Student Attitudes Toward Mathematics — Applied

Percentage of students who strongly agree or agree with the following statements:	All (# = 42 682)	Females (# = 19 113)	Males (# = 23 498)
I like mathematics.	23%	18%	26%
I am good at mathematics.	26%	20%	30%
I understand most of the mathematics I am taught.	39%	34%	43%
The mathematics I learn now is very useful for everyday life.	28%	25%	31%
I need to keep taking mathematics for the kind of job I want after I leave school.	39%	35%	42%
Mathematics is boring.	41%	40%	42%
Mathematics is an easy subject.	18%	14%	23%

Observation

- A higher percentage of males than females in the applied program reported each of the following: that they like mathematics, that they are good at mathematics, that they understand most of the mathematics they are taught, that they need to keep taking mathematics for the kind of job they want after they leave school and that they think mathematics is an easy subject.

Teachers' Professional Learning Environment — Applied[10]

Note: Each teacher had to complete only one questionnaire, so teacher responses are based on one class only. Teachers who taught applied and academic classes chose one class and therefore one program.

School Resources

Percentage of teachers indicating that their Grade 9 mathematics students have access to the following items at school:	(# = 1508)				
	Never or Hardly Ever	A Few Times During the Course	A Few Times a Month	A Few Times a Week	Daily
Computers	32%	31%	9%	7%	19%
Graphing Calculators	13%	38%	18%	10%	18%

Observations

- 63% of the teachers who chose to report on applied indicated that their students had access to computers at school only a few times during the course, or never or hardly ever.
- 51% of the teachers who chose to report on applied indicated that their students had access to graphing calculators only a few times during the course, or never or hardly ever.

Teaching Practices

Percentage of teachers indicating that their Grade 9 mathematics students	Never or Hardly Ever	A Few Times During the Course	A Few Times a Month	A Few Times a Week	Daily
use concrete materials to investigate and gain an understanding of new concepts (# = 1508)	11%	37%	31%	15%	5%
use graphing calculators to explore and investigate mathematical ideas and relationships (# = 1508)	25%	50%	17%	4%	2%
use dynamic geometry software (e.g., The Geometer's Sketchpad, Cabri) (# = 1508)	56%	37%	4%	1%	<1%

Observations

- 88% of the teachers who chose to report on applied indicated that their students used concrete materials to investigate and gain an understanding of new concepts at least a few times during the course.
- 73% of the teachers who chose to report on applied indicated that their students used graphing calculators to explore and investigate mathematical ideas and relationships at least a few times during the course.
- Although the curriculum requires students to demonstrate achievement of certain expectations using dynamic geometry software, 56% of the teachers who chose to report on applied indicated that they never or hardly ever used the software.

[10] Data in the following tables derive from the Grade 9 Teacher Questionnaire.

Percentage of teachers indicating percentages of course time they spend teaching the following mathematics strands:	(# = 1508)				
	1–20%	21–40%	41–60%	61–80%	81–100%
Number Sense and Algebra	11%	66%	15%	4%	1%
Relationships	15%	65%	13%	3%	<1%
Analytic Geometry	37%	55%	4%	1%	<1%
Measurement and Geometry	55%	40%	2%	<1%	<1%

Percentage of teachers indicating that their Grade 9 mathematics students engage in activities related to the following achievement categories:	(# = 1508)				
	Never or Hardly Ever	A Few Times During the Course	A Few Times a Month	A Few Times a Week	Daily
Knowledge/Understanding	<1%	2%	8%	19%	70%
Problem Solving	1%	7%	22%	43%	24%
Communication	1%	8%	21%	33%	34%
Application	<1%	4%	16%	39%	39%

Teachers' Experience and Background

Percentage of teachers indicating that they have been teaching	(# = 1508)		
	5 Years or Less	6–10 Years	11 Years or More
mathematics at the secondary level	48%	17%	34%
Grade 9 mathematics	63%	17%	19%

Observation

- A little more than three-fifths of the teachers who chose to report on applied indicated that they had experience teaching Grade 9 mathematics of five years or less.

Percentage of teachers indicating that while studying to obtain their bachelor's degree (or equivalent), their	(# = 1508)
major area of study was	
mathematics.	32%
a mathematics-related subject.	33%
other.	32%
minor area of study was	
mathematics.	20%
a mathematics-related subject.	40%
other.	35%

Observation

- 65% of the teachers who chose to report on applied indicated that their major area of study was mathematics or a mathematics-related subject.

Percentage of teachers indicating that they have completed or are presently working toward the following:	(# = 1508)
Additional Basic Qualifications in Mathematics	30%
Three-Session Qualifications in Mathematics — Intermediate and Senior Education	9%
Honours Specialist Qualifications in Mathematics	24%

Recommendations[11]

The following recommendations and instructional suggestions are based on

- the 2002–2003 overall achievement results;
- the patterns and trends emerging from the overall results from year to year;
- the data collected from the various questionnaires and
- suggestions from the teacher markers at the EQAO marking centres.

EQAO recommends that

- each **school** study the assessment data and develop an initiative for its school improvement plan geared toward improving student performance, particularly at the applied level. *(21% of applied students achieved the provincial standard.)*
- **principals and teachers** continue to ensure that the instruction in mathematics classes, particularly in the applied program, is aligned with the philosophy, methodology and content of the curriculum. Principals should continue to
  - provide **teachers** with professional development opportunities in best practices for teaching and assessing mathematics (e.g., leading or participating in workshops and conferences, reading professional journals). *(63% of teachers who chose to report on applied and 60% of teachers who chose to report on academic reported that they had experience teaching Grade 9 mathematics of five years or less; 48% of teachers who chose to report on applied and 43% of teachers who chose to report on academic mathematics reported that they had experience teaching mathematics at the secondary level of five years or less.)*
  - provide **teachers** with opportunities to engage in professional discourse with colleagues as they analyze assessment data and plan adaptations to instruction that will improve student learning. *(See passage in italics above.)*
  - include **teachers** of students in Grades 7 and 8 in the initiatives outlined above to ensure that mathematics classes in these intermediate grades are aligned with the philosophy, methodology and content of the curriculum and to reinforce the understanding that there must be shared responsibility for mathematics learning across the intermediate division.
  - encourage **teachers** to
    - identify and clearly communicate the characteristics of successful performance and have students discuss and evaluate their performances against these characteristics. *(See Reference R1.)*
    - present students with practical and purposeful contexts for using the mathematics in the curriculum and linking it to daily life. *(See Reference R2a.)*
    - integrate hands-on materials into classroom activities to engage students in investigating mathematics so that they deepen their understanding of concepts and procedures. *(See Reference R2c.)*
- **school councils** continue to monitor student achievement and take an active role in school improvement.
- **school board** improvement teams, which include administrators, curriculum leaders, parents and teachers, as part of their ongoing improvement efforts, review historical student achievement and contextual data and identify areas for the continuous improvement of achievement in relation to the *Ontario Curriculum* standards for mathematics. The teams could focus on

[11] References to R1, R2 and R3 are identified in Appendix B.

- targeting all categories and strands as well as students in Grade 9 applied mathematics programs. *(21% of applied students achieved the provincial standard.)*
- targeting areas and students in Grade 9 academic mathematics programs in need of additional support. *(34% of academic students did not achieve the provincial standard.)*
- analyzing data, identifying areas of need, setting goals and developing action plans for changes in instruction and assessment, implementing these plans, setting measures for accountability, and monitoring student improvement. *(See Reference R1.)*

- **school boards** continue to
  - provide opportunities for students, especially in the applied program, to have access to technology, including graphing calculators and software such as The Geometer's Sketchpad and Fathom during class time. *(63% of teachers who chose to report on applied indicated that their students had access to computers at school only a few times during the course, or never or hardly ever; 51% of teachers who chose to report on applied indicated that their students had access to graphing calculators at school only a few times during the course, or never or hardly ever. (See Reference R3.)*
  - provide opportunities for teachers to implement technology effectively as a tool for investigating mathematical concepts in the classroom.
  - encourage teachers to meet for conversations about mathematics, teaching, learning and assessment (e.g., in grade or course teams). *(63% of teachers who chose to report on applied and 60% of teachers who chose to report on academic reported that they had experience teaching Grade 9 mathematics of five years or less; 48% of teachers who chose to report on applied and 43% of teachers who chose to report on academic reported that they had experience teaching mathematics at the secondary level of five years or less.)*
  - encourage opportunities for mathematics teachers to meet with colleagues in Grades 7, 8 and 9 who are able to provide leadership in mathematics within the school. *(See notes in italics above.)*
  - provide mentoring by experienced teachers and administrators for teachers new to the teaching profession, or new to teaching Grade 9 mathematics. *(See notes in italics above.)*
- **faculties of education** assist pre-service teachers to gain a thorough understanding of the mathematics curriculum's philosophy, methodology and content, as well as current assessment practices, including large-scale performance-based assessment, and the ways in which assessment assists instruction.
- the **Ontario College of Teachers,** through the Professional Learning Program providers, offer opportunities for professional development that focuses on the relationships among mathematics curriculum, teaching practices and assessment.
- the **Ministry of Education** work with EQAO to use the Grade 9 provincial assessment data accumulated over the past three years to inform the Expert Panel on Students at Risk (Numeracy) and curriculum review activities.

Instructional Suggestions

EQAO's Grade 9 Assessment of Mathematics is based on the expectations in *The Ontario Curriculum, Grades 9 and 10: Mathematics.* It is important that teachers focus their mathematics instruction and assessment on the expectations in *The Ontario Curriculum.*

EQAO suggests that,

- *because the smallest percentages of students reached or exceeded the provincial standards for thinking, inquiry and problem solving, and communication (53% and 55% in academic and 19% and 12% in applied),* teachers focus their instruction as much on understanding the process of learning and thinking mathematically as on answering specific questions. It is important that teachers and students share the strategies they use to solve problems. The communication of reasoning, the ability to listen to the reasoning of others and the adaptation of thinking to encompass the strategies of others are skills necessary for success in mathematics. For example, when students are answering mathematics questions, have them ask themselves,
  - "How do I know I am right?"
  - "How do I know I am done?"
  - "What do I understand now that I didn't before?"
  - "What do I need to remember next time I try a question like this?"
  - "Have I written enough here to allow me to remember the reasoning I used to answer this question?"
  - "How can I explain this to another person?"
- *because only 15% of students in the applied program achieved or exceeded the provincial standard for application and only 17% of students in the applied program achieved or exceeded the provincial standard for relationships,* teachers make connections between the expectations of the strands and provide learning opportunities that cross strands, in order to make efficient use of instructional time. For example,
  - after students collect, organize and record their data, have them make other representations of their data, such as graphs and equations, and discuss how changes in the conditions cause changes in the other representations of the data.
  - after students collect and organize data to optimize surface area for a given volume, have them graph the data and use this representation to make choices of further data to collect.
- *because*
  - *only 15% of students in the applied program achieved or exceeded the provincial standard for application and only 17% of students in the applied program achieved or exceeded the provincial standard for relationships and*
  - *63% of the teachers who chose to report on applied indicated that their students had access to computers at school only a few times during the course, or never or hardly ever, and 51% of the teachers who chose to report on applied indicated that their students had access to graphing calculators at school only a few times during the course, or never or hardly ever,*

  teachers provide students with activities that require them to graph a variety of linear and non-linear relationships. These activities should require students to use graphing calculators and/or graphing software to graph the relationships, change the conditions of the relationships and describe the changes that occur in the notations and in the graphs. For example, as students create tables of values or graphs, have them
  - change the parameters and describe the changes they see.
  - change the graphs and explain how the equations change.

- *because*
  - *only 15% of students in the applied program achieved or exceeded the provincial standard for application and only 17% of students in the applied program achieved or exceeded the provincial standard for relationships and*
  - *63% of the teachers who chose to report on applied indicated that their students had access to computers at school only a few times during the course, or never or hardly ever and 51% of the teachers who chose to report on applied indicated that their students had access to graphing calculators at school only a few times during the course, or never or hardly ever,*

  teachers provide students with relationships activities that engage them in collecting, representing, analyzing and interpreting data. Students need to use manipulatives and data collection technology to collect original data. Analyzing real-world data connects students to the data in ways that arbitrary equations in texts do not. Students need to see a connection between themselves and the data. For example, students could
  - use a motion detector to match the walk of another student, then describe differences and similarities.
  - use a temperature probe to collect data about a cup of coffee cooling on a table, then describe what happens when conditions change.
  - use manipulatives to investigate the relationship between the height of a square-based prism and its surface area, given a fixed volume.
- *because 12% of students in the applied program and 55% of students in the academic program achieved or exceeded the provincial standard for communication,* teachers have students regularly discuss and describe their thinking about mathematics and interpret and evaluate what other students say. A great deal of discussion in a common language is required for students to construct links between their informal ideas and the language and symbols of mathematics. For example, teachers could
  - implement a class rule that requires students to ask three other students before approaching the teacher with a question.
  - have students work in small groups and share their thinking with one another before the class reflects as a group.
  - have pairs of students review and edit each other's solutions.
- *because the research, resources and workshops developed and supported by the Ministry of Education focus on strategies that are especially good for students in Grade 9 applied mathematics, and their scores are quite low overall, with only 21% performing at or above the provincial standard,* teachers regularly arrange students in groups to engage in the activites in the Ministry of Education TIPS resource: http://www.curriculum.org/occ/tips/index.shtml. Examples include
  - Think, Pair, Share;
  - Placemat;
  - Jigsaw;
  - Numbered Heads and
  - Inside Outside Circle.

  Group activities facilitate mathematical discussion and the testing of ideas. In groups, learners are able to interact and perform actions that are beyond their individual level of performance.

- *because only 15% of students in the applied program achieved or exceeded the provincial standard for application and only 17% of students in the applied program achieved or exceeded the provincial standard for relationships,* teachers focus their instruction on student-centred investigations. Students gain a deeper understanding when they investigate concepts, discuss mathematics and synthesize their findings among their peers. *(See Reference R2c.)*
  - use Think , Pair, Share to have students discover the effect of changing the *y*-intercept or slope of a line.
  - use group work to have students investigate the relationship between the perimeter and area of a figure when one of the measures is fixed.
- teachers provide opportunities for students to reflect on, synthesize and practise the skills that have been taught. Students need to practise their skills to ensure that they have learned the concepts. Without overburdening students with repetitive busywork, have them
  - write reflections on their learning in mathematics journals.
  - practise the skills and knowledge they have learned through interaction with peers and the teacher by doing pertinent questions individually before being assessed. *(See Reference R1.)*
- teachers of students in the academic program focus on enabling students to generalize mathematical ideas by teaching them to represent their ideas in multiple formats, such as graphs, tables, mathematical language and algebraic expressions. Teachers of students in the applied program should focus on enabling students to develop mathematical ideas with hands-on activities and to represent the ideas in multiple formats, such as graphs and tables, and in common language. *(See Reference R2b for academic and R2c for applied.)*
- teachers provide regular opportunities for students to read and discuss materials that deal with everyday mathematics use. It is important that students not only read, but interpret, discuss and write about everyday mathematical ideas. For examples, students could read
  - newspaper articles containing graphs, statistics and ratios;
  - store flyers;
  - instructions for games or “how to” manuals and
  - schedules.

Appendix A — Definitions of Categories and Strands

Categories
Knowledge and Understanding – understanding concepts – performing algorithms, operations and procedures
Application – selecting concepts, formulas, algorithms and tools to fit the information given
Thinking, Inquiry and Problem Solving – reasoning – applying the steps of an inquiry or problem-solving process
Communication – explaining reasoning – using mathematical language, symbols, visuals and conventions

Strands
Number Sense and Algebra – applying essential numeric skills in solving new problems within a context (rather than in isolation) – applying algebraic concepts and skills (basic exponent rules, operations with first-degree polynomials and solving first-degree equations) necessary for the study and application of relations (i.e., consolidating numerical skills by using them in a variety of contexts)
Relationships – identifying and understanding the properties of linear relations through the collection and interpretation of data from a variety of real-life situations and the creation of algebraic models for the data (e.g., determining relationships between two variables by collecting and analyzing data)
Analytic Geometry – using various mathematical forms to demonstrate understanding of the geometry of the *xy*-plane, with a focus on linear relations and properties of slope (e.g., graphing a line and writing the equation of a line using given information)
Measurement and Geometry – understanding and using formulas and applications of three-dimensional figures to explore the relationships between measurement and geometry (e.g., relationship between volume and surface area, varying of one dimension on a measure) – demonstrating an understanding of some properties of triangles and quadrilaterals (e.g., determining the optimal values of various measurements through investigations facilitated by the use of concrete materials, diagrams and calculators or computer software)

Appendix B — References

R1. The Ontario Curriculum, Grades 9 to 12: Program Planning and Assessment

Page 13: Assessment and Evaluation of Student Achievement

In order to ensure that assessment and evaluation are valid and reliable, and that they lead to the improvement of student learning, teachers must use assessment and evaluation strategies that:

- address both what students learn and how well they learn;
- are based both on the categories of knowledge and skills and on the achievement level descriptions given in the achievement chart that appears in the curriculum policy document for each discipline;
- are varied in nature, administered over a period of time, and designed to provide opportunities for students to demonstrate the full range of their learning;
- are appropriate for the learning activities used, the purposes of instruction, and the needs and experiences of the students;
- are fair to all students;
- accommodate the needs of exceptional students, consistent with the strategies outlined in their Individual Education Plan;
- accommodate the needs of students who are learning the language of instruction;
- ensure that each student is given clear directions for improvement;
- promote students' ability to assess their own learning and to set specific goals;
- include the use of samples of students' work that provide evidence of their achievement;
- are communicated clearly to students and parents at the beginning of the course and at other appropriate points throughout the course.

R2. The Ontario Curriculum, Grades 9 and 10: Mathematics

a) Page 6: Teaching Approaches

All learning, especially new learning, should be embedded in a context. Well-chosen contexts for learning are those that are broad enough to allow students to explore and develop initial understandings, to identify and develop relevant supporting skills, and to gain experience with interesting applications of the new knowledge. Such rich environments open the door for students to see the "big ideas" of mathematics — the major underlying principles, such as pattern or relationship. This ability to understand key principles will encourage students to continue using mathematical reasoning throughout their lives.

b) Page 9: Principles of Mathematics, Grade 9, Academic (MPM1D)

This course enables students to develop generalizations of mathematical ideas and methods through the exploration of applications, the effective use of technology, and abstract reasoning. Students will investigate relationships to develop equations of straight lines in analytic geometry, explore relationships between volume and surface area of objects in measurement, and apply extended algebraic skills in problem solving. Students will engage in abstract extensions of core learning that will deepen their mathematical knowledge and enrich their understanding.

c) Page 18: Foundations of Mathematics, Grade 9, Applied (MFM1P)

This course enables students to develop mathematical ideas and methods through the exploration of applications, the effective use of technology, and extended experiences with hands-on activities. Students will investigate relationships of straight lines in analytic geometry, solve problems involving the measurement of 3-dimensional objects and 2-dimensional figures, and apply key numeric and algebraic skills in problem solving. Students will also have opportunities to consolidate core skills and deepen their understanding of key mathematical concepts.

R3. The Ontario Curriculum, Grades 9 to 12: Program Planning and Assessment

Page 9: The Role of Technology in the Curriculum

Increasing reliance on computers, telecommunication networks, and information technologies in society and the workplace makes it essential for students to become computer literate and to develop "information literacy" skills. Information literacy is the ability to access, select, gather, critically evaluate, create, and communicate information, and to use the information obtained to solve problems and make decisions. In preparation for further education, employment, citizenship, and lifelong learning, students must be capable of deriving meaning from information by using a wide variety of information literacy skills.

As part of their training in computer and information literacy, students should become familiar with a range of available software programs. Among the applications that can aid student learning are simulations, multimedia resources, databases, and computer-assisted learning modules, many of which have been developed for use in particular disciplines. Students will also be expected to use software applications that help them develop general skills in such areas as writing, problem solving, research, and communication. Through e-mail, students can communicate with other students and with experts in various fields across Ontario and around the world. It is important that students learn to critically evaluate the accuracy, validity, currency, comprehensiveness, and depth of the information they access using information technology, particularly the Internet. In general, teachers must try to ensure that students acquire the knowledge, skills, and attitudes that will allow them to use computer and information technology safely, effectively, confidently, and ethically.