CHAPTER 3: New Zealand Year 9 Students' Mathematics Achievement

KEY POINTS

- There was a small, non-statistically significant decrease in New Zealand Year 9 students' mean mathematics achievement score in 1998 compared with that of their Year 9 counterparts in 1994.
- There was little change in the distribution of mathematics scores from 1994 to 1998, although a slightly higher proportion of New Zealand Year 9 students achieved very low scores in 1998 than in 1994.
- New Zealand Year 9 girls' mathematics achievement in 1998 was virtually the same as for Year 9 girls in 1994.
- New Zealand Year 9 boys in 1998, on average, achieved slightly lower scores than their 1994 counterparts, but the difference was not of statistical significance.
- No change was evident in the relative mean mathematics performance of the four main ethnic groupings of Year 9 students in New Zealand between 1994 and 1998.
- There was a small but statistically significant decrease in the mean mathematics achievement for Year 9 students in schools with Targeted Funding for Educational Achievement indicator in the deciles 4 to 7 band from 1994 to 1998.
- In 1998, student performance across the different mathematics content areas was generally consistent. The one exception was in *Geometry*, where New Zealand Year 9 student achievement was relatively weak.

INTRODUCTION

This chapter presents New Zealand Year 9 students' mathematics achievement in TIMSS-98 in a New Zealand context[1]. Among other things, their achievement is considered in terms of the main ethnic grouping with which they identified, their gender, and the type of school they were attending. When it is possible, the mathematics achievement of Year 9 students in 1998 is compared to the performance of their Year 9 counterparts in 1994. In the latter half of the chapter, Year 9 student achievement in each of the content areas of mathematics is considered at a national and international level.

OVERALL ACHIEVEMENT RESULTS

Why are comparisons being made with Year 9 students in 1994?

Firstly, to recap: TIMSS-98 was designed to measure trends in Year 9 students mathematics and science achievement. It is also, in part, a quasi-longitudinal study of a cohort: the cohort assessed in TIMSS-98 as Year 9 students was assessed in TIMSS-94 as Year 5 students (although they were not necessarily the same individual students who took part in each study). That is, the study has provided the opportunity for New Zealand to examine the 'progress' the younger cohort had made in four years, as they have progressed into secondary school. While it is not possible to *directly* compare the mathematics achievement of the cohort as Year 5 students to that of the cohort as Year 9 students (because of the independent assessments and scales involved) there are a number of approaches that facilitate comparative analysis. For example, the relative performance of sub-groups within the cohort that were observed in 1994 (as Year 5 students) and 1998 (as Year 9 students) can be compared. Further to this, many aspects of the mathematics achievement of Year 9 students in TIMSS-98 can be compared with those of their TIMSS-94 Year 9 counterparts.

The overall trend from 1994 to 1998

The mean mathematics scores for Year 9 students in each of TIMSS-94 and TIMSS-98 are presented in Table 3.1. As noted in Chapter 1, Item Response Theory (IRT) methods have been used to report student achievement results. The technique summarises attributes about the test items as well as the students, taking in to account that students answered subsets of items[2] (see also TN.2 in Technical Notes).

As already noted in Chapter 2, although the mean score for Year 9 students in mathematics in 1998 was slightly lower than the mean for 1994, the difference was not of statistical significance.

---

[1] *As explained in more detail in Chapter 1, TIMSS was administered in Southern Hemisphere countries in 1994, and TIMSS-R was administered in 1998. In Northern Hemisphere countries the same studies were administered in 1995 and 1999. In this chapter the two assessments will be referred to as TIMSS-94 and TIMSS-98.*

[2] *Since mean percent correct scores were used when reporting on student achievement in the TIMSS-94 national (NZ) publications, some of analyses have been reproduced to enable comparisons to be made between the two assessments. These are reported in the tables appended to this report.*

TABLE 3.1: YEAR 9 STUDENTS' MEAN MATHEMATICS SCORES IN 1994 AND 1998

Year 9 students	Mean mathematics scale scores (se)	
	1994	1998
Overall mean	501 (4.7)	491 (5.2)

(se) Standard errors appear in parentheses. Also refer to TN.3 in Technical Notes. We can say with 95% confidence that the true population mean lies within two standard errors of the observed (reported) mean.

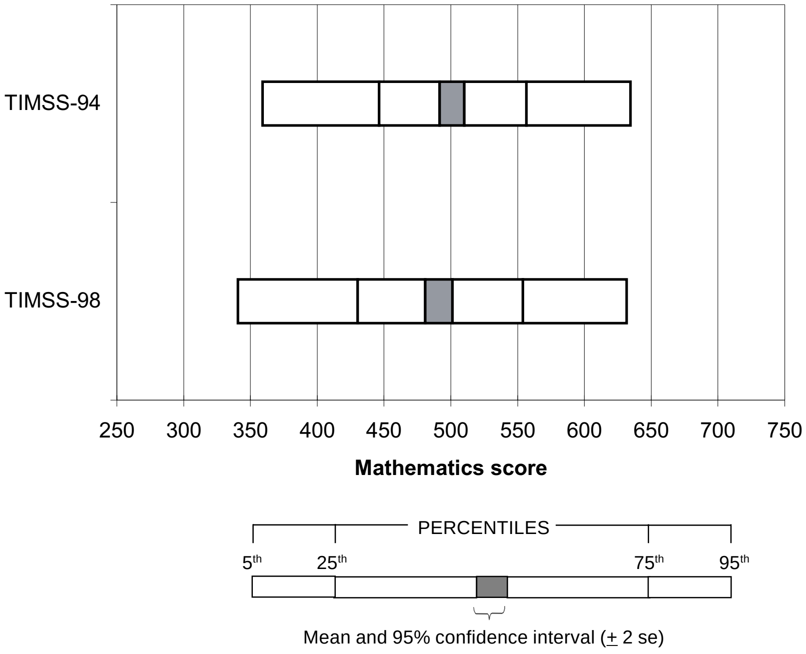
One of the key results for New Zealand in TIMSS-94 was the relatively poor performance of New Zealand Year 5 (standard 3) students compared to the international mean for the 26 countries (see Mullis et al, 1997). Since most of the 1994 Year 5 cohort were Year 9 students in 1998, the TIMSS-98 findings suggest, that in four years, they had progressed to a level not dissimilar to that of Year 9 students in 1994.

Figure 3.1 presents the distribution of New Zealand Year 9 students' mathematics scores in 1994 and 1998 (see also Table B.1, Appendix B).

Interpretation of the percentiles

In Figure 3.1 the percentages of students performing below or above particular points on the achievement scale are shown for each year. The 5th percentile and 95th percentiles represent the outer limits of achievement. The lowest outer limit is the 5th percentile — five percent of Year 9 students point achieved scores below this point, and 95 percent of Year 9 students achieved above this point. The highest outer limit is the 95th percentile — the point above which only five percent of Year 9 students achieved above this point, while 95 percent of students achieved below this point. Ninety percent of the Year 9 student scores were between the 5th and 95th percentiles, while 50 percent of Year 9 students' scores were between the 25th and 75th percentiles.

FIGURE 3.1: THE DISTRIBUTION OF YEAR 9 STUDENTS' MATHEMATICS SCORES IN 1994 AND 1998

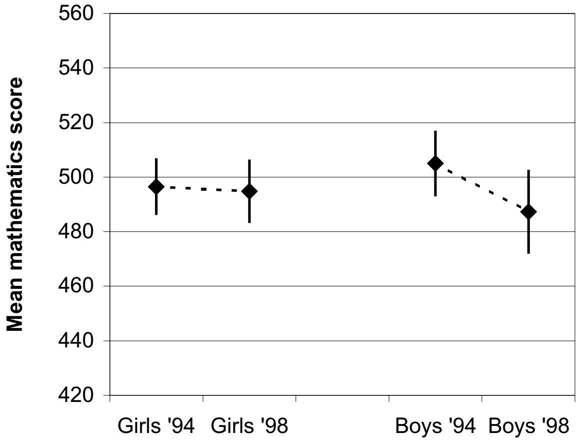


At first glance there appears to be very little difference in the distributions of scores in 1994 and 1998, particularly among the higher achieving part of the population. As already noted in Chapter 2, eight percent of New Zealand Year 9 students reached the international *Top 10% Benchmark* in each of TIMSS-94 and TIMSS-98. This stability in the higher achieving part of the population is further illustrated by the fact that 10 percent of New Zealand students scored 604 or more scale score points in 1994 and again in 1998. However, there was less stability in the lower performing segment of the population. This is illustrated in Figure 3.1, where it can be seen that the 25th and the 5th percentiles are lower in 1998 than in 1994. This suggests that, in 1998, the lower performing students achieved scores lower than their Year 9 counterparts in 1994.

GENDER AND MATHEMATICS ACHIEVEMENT

Figure 3.2 presents the mean scores for Year 9 girls and boys in both 1994 and 1998. While Year 9 boys, on average, achieved slightly lower mathematics scores in 1998 than their counterparts in 1994, the difference was not of statistical significance[3]. The mean achievement for Year 9 girls was almost the same in both years. (See Table B.2, Appendix B for the means and standard errors for 1994 and 1998.)

FIGURE 3.2: YEAR 9 STUDENTS' MEAN MATHEMATICS SCORES IN 1994 AND 1998, BY GENDER



For both boys and girls the difference between mean scores in 1994 and 1998 was not statistically significant.

The data points are the mean scores. The vertical lines extending from the data point show the 95% confidence interval around the mean, ie, ± 2 standard errors.

Whereas in 1994 Year 9 boys achieved scores, on average, slightly higher than their female counterparts, in 1998 the converse was true. That is, Year 9 girls achieved higher mean scores in mathematics than Year 9 boys, although, as was the case in 1994, the difference was not of statistical significance. It is worth remembering that, of the 26 countries to participate in TIMSS-94, New Zealand was one of eight where, on average, Year 5 girls achieved mathematics scores higher (although not statistically significantly so) than their male counterparts. It appears, therefore, that this gender relativity has carried through from the middle primary through to the lower secondary level (see Chamberlain, 1997b; also Mullis et al, 1997).

Figure 3.3 shows the distributions of mathematics scores for Year 9 girls and boys in both 1994 and 1998. As can be seen in the figure, the range of scores (the difference between the 5th and 95th percentiles)

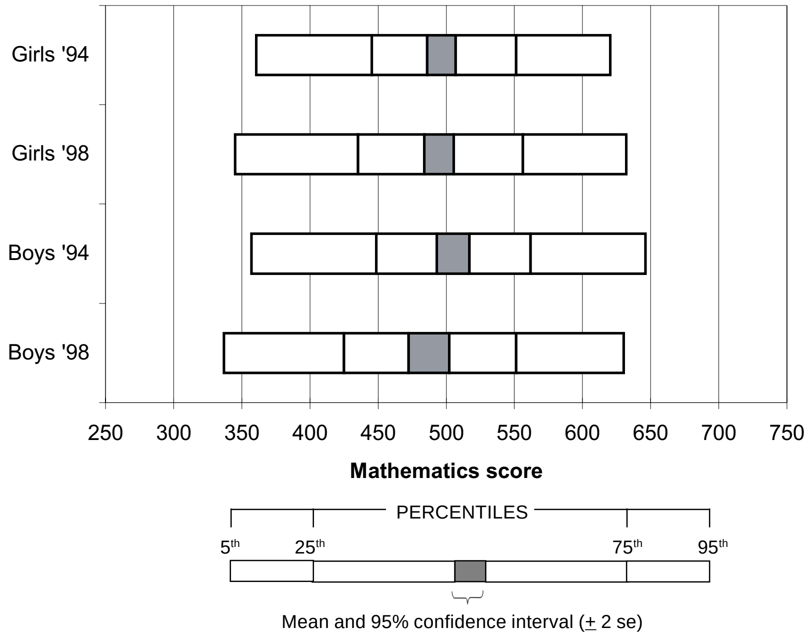
---

[3] *Throughout this chapter, differences are described as 'significant', or 'statistically significant' where significance tests meet $\alpha = 0.05$ (ie, the 5% level); see also TN.4 in Technical Notes.*

for girls in 1998 was greater than in 1994. Note that the highest achieving girls in 1998 gained slightly higher scores than their 1994 female counterparts, and the lowest achieving girls achieved gained slightly lower scores than their counterparts in 1994.

However, for boys the picture was somewhat different. For example, in 1998 the scores gained by boys at each of the 95th, 75th, 50th, 25th and 5th percentiles were all slightly lower than they had been at these percentiles in 1994. To further illustrate, the 25th percentile score for boys was 449 in 1994 but 425 in 1998; and the 5th percentile (ie, at or below which the lowest performing five percent of boys scored) was 357 in 1994 but only 337 in 1998. While these differences in scores do not represent a change in Year 9 boys' mean mathematics scores, the results clearly indicate that there continued to be a group of boys who were very weak in mathematics. (Also see Table B.3, Appendix B for details of the percentiles).

FIGURE 3.3: THE DISTRIBUTION OF YEAR 9 STUDENTS' MATHEMATICS SCORES IN 1994 AND 1998, BY GENDER



When considering the achievements of 'boys' and 'girls' it is important to remember that they are not homogenous groups of students. Alton-Lee and Praat (2000), for example, in their review of literature on gender differences in New Zealand schools highlighted the complex nature of the interactions between gender and ethnicity. An examination of the achievement of Year 9 girls relative to Year 9 boys within each main ethnic grouping is discussed in the latter half of the next section.

ETHNICITY AND MATHEMATICS ACHIEVEMENT

Table 3.2 presents the mean mathematics scores for the five ethnic groupings[4] for both 1994 and 1998. For each ethnic grouping there was no statistically significant difference between the mean scores for 1994 and 1998. As was the case in 1994, Maori and Pacific[5] students in 1998 achieved lower mean scores in 1998 than their Asian[6] and Pakeha/European counterparts.

---

[4] *See Chapter 5 for a description of the ethnicity classification used in New Zealand.*

[5] *'Pacific' includes students who identified themselves as Samoan, Cook Islands Maori, Tongan, Niuean, or 'other Pacific Island'.*

[6] *'Asian' includes students who identified themselves as Chinese, Indian (incl. Fijian Indian), or 'other Asian'.*

TABLE 3.2: YEAR 9 STUDENTS' MEAN MATHEMATICS SCORES IN 1994 AND 1998, BY ETHNIC GROUPING

Year	Mean mathematics scale score (se)				
	Pakeha/ European	Maori	Pacific	Asian	Other ethnic groups
1994	517 (4.5)	463 (6.4)	430 (6.8)	532 (10.9)	522 (16.8)
1998	508 (5.1)	454 (5.0)	429 (10.4)	534 (10.0)	508 (15.3)

Notes: see Chapter 5 for proportions of students in each ethnic grouping for 1994 and 1998.
(se) Standard errors appear in parentheses.

Due to the small proportion of Year 9 students in the 'other ethnic groups[7] category in both 1994 and 1998, the remainder of the discussion will focus only on students in the four main groupings — Pakeha/ European, Maori, Pacific, and Asian.

Table 3.3 presents the results of a comparison of means for the four main groupings.

Reading the significance table

Table 3.3 is read so that an arrow pointing upwards indicates the group in the **row** has a significantly higher mean score than the corresponding group in the **column** (eg, Pakeha/European had a significantly higher mean than Maori). A downward arrow indicates a significantly lower mean score (of the row group relative to the column group), and a circle indicates no significant difference between the groupings.

TABLE 3.3: COMPARISON OF YEAR 9 STUDENTS' MEAN MATHEMATICS SCORES IN 1998, BY ETHNIC GROUPING

Ethnic grouping	Pakeha/ European	Maori	Pacific	Asian
Pakeha/ European		▲	▲	●
Maori	▼		●	▼
Pacific	▼	●		▼
Asian	●	▲	▲	

▲ Mean achievement was statistically significantly higher
● No difference in mean achievement
▼ Mean achievement was statistically significantly lower

Note: Significance tests adjusted for multiple comparison of means. See TN.5 in Technical Notes. Also, see Table B.4 in Appendix B for t values.

---

[7] *'Other ethnic groups' includes students who identified themselves as being 'Middle Eastern', 'African', etc.*

The table shows that, in 1998, the mean mathematics scores for students in the Pakeha/European and Asian groupings were statistically significantly higher than those achieved by students in the Maori and Pacific ethnic groupings. On average, the performance of students in each of the Maori and Pacific ethnic groupings was about the same. Similarly, there was no statistical difference between the mean achievement of students in the Pakeha/European and Asian groupings.

As noted above there were significant differences in mean achievement between the ethnic groupings. How big were these differences, and was there any change since 1994? Effect sizes can be used to illustrate the size or magnitude of the difference between two groups (see TN.6 in Technical Notes for further details). Effect sizes were calculated using mean achievement scores for Year 5 and Year 9 students in 1994, as well as for Year 9 students in 1998 — these are presented in Tables B.5a to B.5c in Appendix B.

In terms of trends, the magnitude of the differences between means achieved by Year 9 students in each of the Maori, Pacific and Pakeha/European ethnic groupings 1998 were about the same as those for Year 5 students in these ethnic groupings in 1994. One inference that can be drawn from this information is that the magnitudes of the gaps in mean achievement between Pakeha/European and both Maori and Pacific students were maintained as students progressed from the middle primary level in 1994 through to the lower secondary level in 1998. By way of contrast, the effect sizes between Asian and every other ethnic group were higher in Year 9 in 1998 than in Year 5 in 1994, indicating that Asian students had improved relative to all other ethnic groupings across this period. However, it is possible that the Asian population has been subject to greater migration effects and the consequent variation in this cohort could have impacted on achievement.

It is also important to remember there were very high performing and very low performing students in all ethnic groupings. Figures 3.4a and 3.4b present graphical representations of the distributions of scores for each ethnic grouping in 1994 and 1998 (see Table B.6, Appendix B for details of the percentiles). The figures illustrate the variation in achievement within each ethnic grouping as well as the variation in achievement between groupings. However, readers should note there are greater errors around the percentile estimates for Pacific and Asian populations (because of their relatively small samples) which must be considered when interpreting these results.

Figure 3.4b shows, for example, that five percent of Pacific students achieved a score of greater than 600 whereas 25 percent of Asian students achieved a score greater than this scale score in 1998. Furthermore, one-half of Maori students achieved a score of approximately 450 or less compared to just 25 percent of Pakeha/European students.

FIGURE 3.4A: THE DISTRIBUTION OF YEAR 9 STUDENTS' MATHEMATICS SCORES IN 1994, BY ETHNIC GROUPING

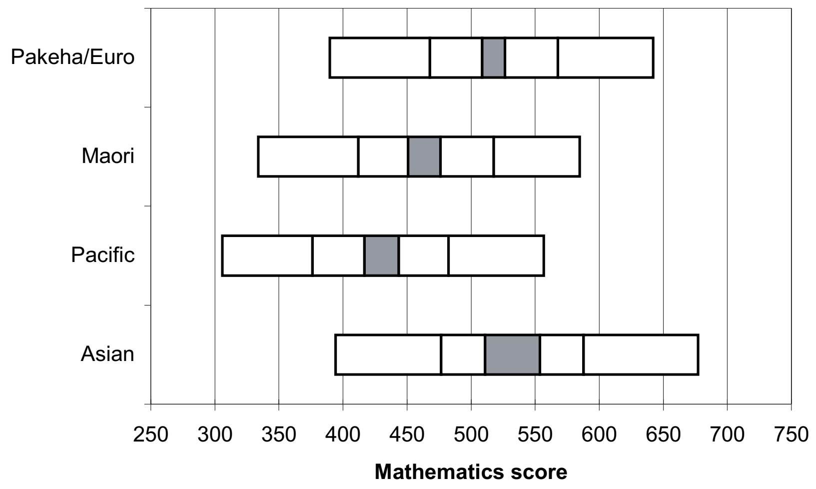
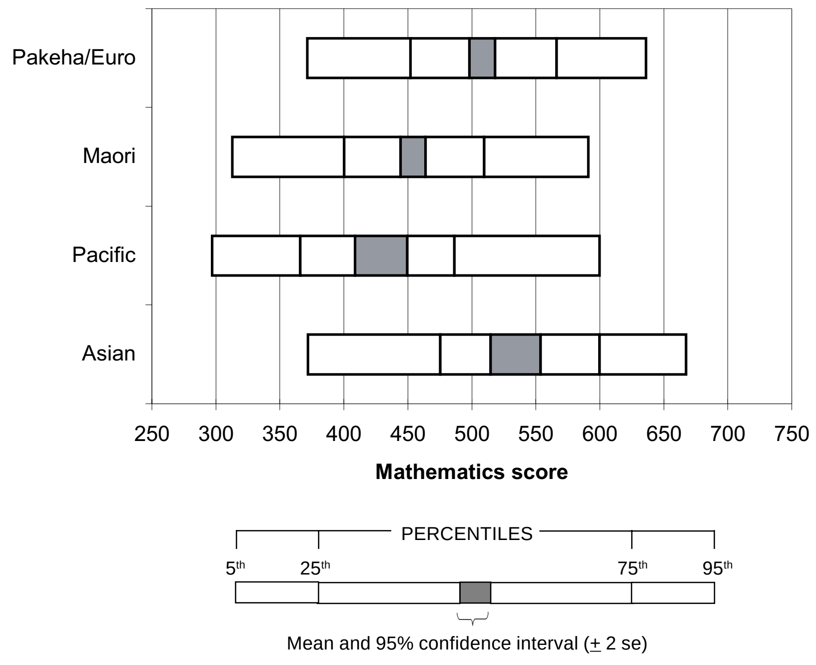


FIGURE 3.4B: THE DISTRIBUTION OF YEAR 9 STUDENTS' MATHEMATICS SCORES IN 1998, BY ETHNIC GROUPING



Ethnicity, gender, and mathematics achievement

The mean mathematics scores for Year 9 girls and boys in 1998 within each ethnic grouping are presented in Table 3.4.

TABLE 3.4: YEAR 9 STUDENTS' MEAN MATHEMATICS SCORES IN 1998, BY ETHNIC GROUPING AND GENDER

1998 assessment	Mean mathematics scale scores (se)							
	Pakeha/European		Maori		Pacific		Asian	
	girls	boys	girls	boys	girls	boys	girls	boys
	513 (5.4)	503 (7.5)	461 (5.7)	447 (6.7)	421 (13.1)	438 (16.1)	530 (13.9)	539 (11.8)
Overall mean	508 (5.1)		454 (5.0)		429 (10.4)		534 (10.0)	

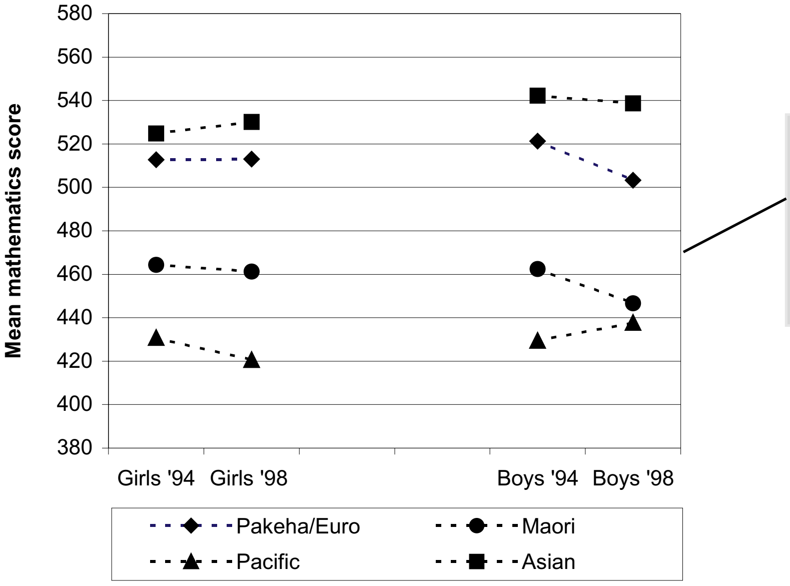
(se) Standard errors appear in parentheses.

Year 9 Pakeha/European girls and Maori girls, on average, achieved nominally higher mathematics scores than boys in their respective ethnic groupings. Pacific and Asian girls, on average, achieved nominally lower scores than their male counterparts. However, none of the differences between girls' and boys' mean mathematics scores in each of the groupings were of statistical significance.

This overall finding is consistent with the findings from TIMSS-94 at the lower secondary level, although the achievement patterns within particular groups were slightly different (see Table B.7, Appendix B for details).

Figure 3.5 presents trends in mean achievement in 1994 and 1998 by ethnic grouping and by gender. While both Pakeha/European and Maori boys, on average, achieved lower mathematics scores in 1998 than their counterparts in 1994, with differences of 18 and 15 scale score points respectively, none of the differences in mean scores across the four year period were statistically significant.

FIGURE 3.5: YEAR 9 STUDENTS' MEAN MATHEMATICS SCORES IN 1994 AND 1998, BY ETHNIC GROUPING AND GENDER



For both boys and girls in each ethnic grouping the difference between mean scores in 1994 and 1998 was not statistically significant.

SOCIO-ECONOMIC FACTORS AND MATHEMATICS ACHIEVEMENT

In order to address barriers to learning associated with socio-economic disadvantage, the New Zealand Ministry of Education allocates funding to state and state-integrated schools based on their Targeted Funding for Educational Achievement (TFEA) indicator. Schools are ranked into 10 groupings, or deciles, with decile 1 schools being those drawing students from communities categorised as having low socio-economic status while decile 10 schools draw from communities categorised as having high socio-economic status. For the following discussion, schools have been grouped into three broad bands — low (deciles 1–3), medium (deciles 4–7), and high (deciles 8–10). Schools without a TFEA indicator are independent (or private) schools.

The mean mathematics scores for Year 9 students in schools in each TFEA decile band, along with the proportions of students in each band are presented in Table 3.5. (Table B.8 in Appendix B provides corresponding data for 1994). Note: that the proportions of Year 9 students in TIMSS-98 in schools in each decile band were consistent with the national Year 9 student enrolments in secondary and composite schools in 1998.[8]

TABLE 3.5: YEAR 9 STUDENTS' MEAN MATHEMATICS SCORES IN 1998, BY SCHOOLS' TARGETED FUNDING FOR EDUCATIONAL ACHIEVEMENT (TFEA) DECILE BAND

Schools' TFEA decile band	1998	
	% of students	Mean mathematics score (se)
Low (deciles 1-3)	18	453 (12.9)
Medium (deciles 4-7)	48	476 (6.3)
High (deciles 8-10)	30	530 (9.6)
No TFEA indicator (ie, private schools)	4	551 (11.4)

(se) Standard errors appear in parentheses.

Refer to the text above for an outline of the TFEA decile bands.

Perhaps one of the more important results that can be observed from Table 3.6 is that there were no statistically significant differences between means for students in schools in the low and medium bands. It is also important to remember that students in schools within any particular TFEA decile band are not homogeneous in terms of achievement. That is, there were very high and very low performing students in all TFEA decile bands as illustrated in Figure 3.6 (also see Table B.9, Appendix B).

---

[8] *According to Ministry of Education data, the proportion of Year 9 student enrolment at deciles 1–3, 4–7 and 8–10 secondary and composite schools were 20%, 45% and 30% respectively. Students at independent schools (no decile) accounted for about 4%. See also* Education Statistics for 1998, *Ministry of Education, 1999.*

Reading the significance table

Table 3.6 is read so that an arrow pointing upwards indicates the group in the **row** has a significantly higher mean score than the corresponding group in the **column** (eg, students in schools with high TFEA deciles achieved a significantly higher mean than students in schools with low TFEA deciles). A downward arrow indicates a significantly lower mean score (of the row group relative to the column group), and a circle indicates no significant difference between the groupings.

TABLE 3.6: COMPARISON OF YEAR 9 STUDENTS' MEAN MATHEMATICS SCORES IN 1998, BY SCHOOLS' TARGETED FUNDING FOR EDUCATIONAL ACHIEVEMENT (TFEA) DECILE BAND

Schools' TFEA decile band	Low (deciles 1-3)	Medium (deciles 4-7)	High (deciles 8-10)	No TFEA indicator
Low (deciles 1-3)		●	▼	▼
Medium (deciles 4-7)	●		▼	▼
High (deciles 8-10)	▲	▲		●
No TFEA indicator	▲	▲	●	

▲	Mean achievement was statistically significantly higher
●	No difference in mean achievement
▼	Mean achievement was statistically significantly lower

Note: Significance tests adjusted for multiple comparison of means. See TN.5 in Technical Notes. Also, see Table B.10 in Appendix B for t values.

Refer to page 44 for an outline of the TFEA decile bands.

FIGURE 3.6: THE DISTRIBUTION OF YEAR 9 STUDENTS' MATHEMATICS SCORES IN 1998, BY SCHOOLS' TARGETED FUNDING FOR EDUCATIONAL ACHIEVEMENT (TFEA) DECILE BAND

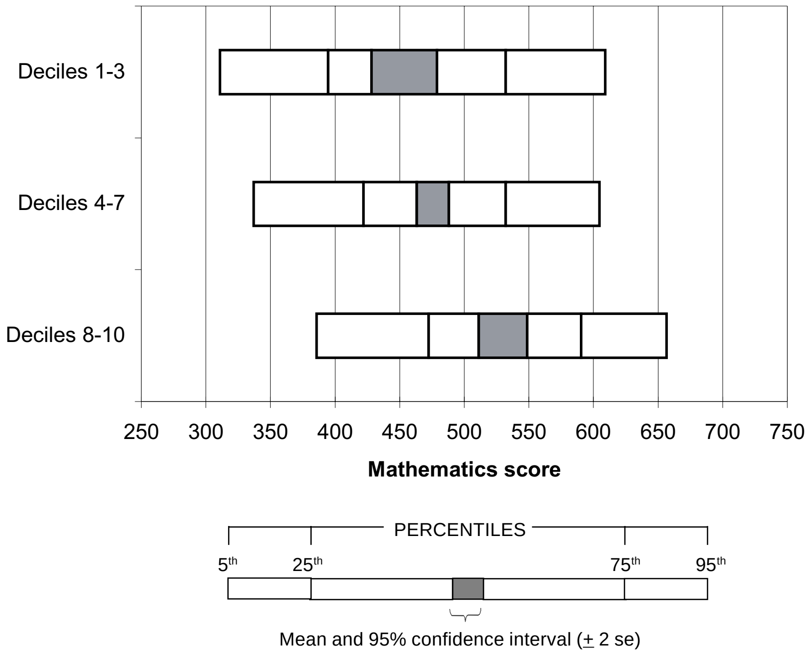
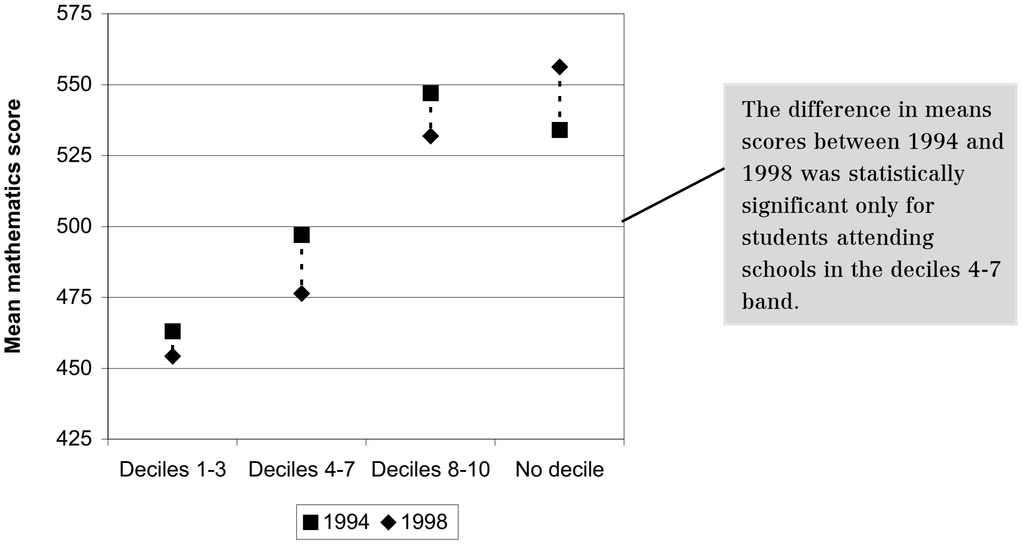


Figure 3.7 shows the mean mathematics scores for students in schools in each TFEA decile band in 1994[9] and 1998[10]. It is important to note that the comparisons made are with respect to the students attending schools in each band; although representative samples of schools participated in TIMSS-94 and TIMSS-98, the schools in TIMSS-98 were not necessarily the same schools that particpated in TIMSS-94.

FIGURE 3.7: YEAR 9 STUDENTS' MEAN MATHEMATICS SCORES IN 1994 AND 1998, BY SCHOOLS' TARGETED FUNDING FOR EDUCATIONAL ACHIEVEMENT (TFEA) DECILE BAND



The difference in means scores between 1994 and 1998 was statistically significant only for students attending schools in the deciles 4-7 band.

Note: refer to page 44 for an outline of the TFEA decile bands.

The mean mathematics scores for Year 9 students in schools within each TFEA band in 1998 were, generally, lower than those of their counterparts in 1994. However the only difference found to be statistically significant between 1994 and 1998 was the decrease in mean mathematics scores for students in the medium TFEA decile band schools. This apparent decrease in achievement needs to be explored further before any explanation can be offered. Those schools with no TFEA indicator ('no decile') are independent schools — and although there was a noticeable difference in the mean mathematics scores achieved by students in these private schools in 1994 and 1998, it was not statistically significant.

SCHOOL TYPE AND MATHEMATICS ACHIEVEMENT

Table 3.7 presents the mean mathematics scores for Year 9 students in each of the three types of schools along with proportions of students attending these schools.

Year 9 girls in single-sex schools achieved a statistically significantly higher mean mathematics score than Year 9 students in coeducational schools (there was no difference between Year 9 girls' and boys' mean mathematics achievement in coeducational schools). While there is a small difference between the mean scores of boys and girls in single-sex schools this was not of statistical significance. Table 3.8 summarises the findings.

---

[9] *The 1995 TFEA data was used when reporting TIMSS analyses.*

[10] *The TFEA indicator assigned to schools in 1998.*

TABLE 3.7: YEAR 9 STUDENTS' MEAN MATHEMATICS SCORES IN 1998, BY SCHOOL TYPE

School type	1998	
	% of students	Mean mathematics score (se)
Coeducational	68	479 (5.9)
Single-sex boys'	16	507 (19.1)
Single-sex girls'	17	524 (11.6)

(se) Standard errors appear in parentheses.

Reading the significance table

Table 3.8 is read so that an arrow pointing upwards indicates the group in the **row** has a significantly higher mean score than the corresponding group in the **column** (eg, girls in single-sex schools achieved a significantly higher mean than students in coeducational schools). A downward arrow indicates a significantly lower mean score (of the row group relative to the column group), and a circle indicates no significant difference between the groupings.

TABLE 3.8: COMPARISON OF YEAR 9 STUDENTS' MEAN MATHEMATICS SCORES IN 1998, BY SCHOOL TYPE

School type	Coeducational	Single-sex boys'	Single-sex girls'
Coeducational		●	▼
Single-sex boys'	●		●
Single-sex girls'	▲	●	

▲	Mean achievement was statistically significantly higher
●	No difference in mean achievement
▼	Mean achievement was statistically significantly lower

Note: Significance tests adjusted for multiple comparison of means. See TN.5 in Technical Notes. Also, see Table B.11 in Appendix B for t values.

While the mathematics scores for students attending single-sex schools were, on average, higher than those for students attending coeducational schools, previous research undertaken in New Zealand has shown that socio-economic background and initial ability of the student intake into single-sex schools are likely to account for the differences in educational outcomes (eg, Nash & Harker, 1997; Nash & Harker, 1998, cited in Wilkinson et al, 2000). While it was not possible to examine students' initial ability in TIMSS-98, a cursory examination of mathematics achievement alongside two proxy socio-economic indicators was undertaken. Firstly, the indicator used for Targeted Funding for Educational Achievement (TFEA decile), a school level indicator; and secondly, a student level proxy for wealth, the Home Education Resources (HER) Index (this index is explained in more detail in Chapter 5).

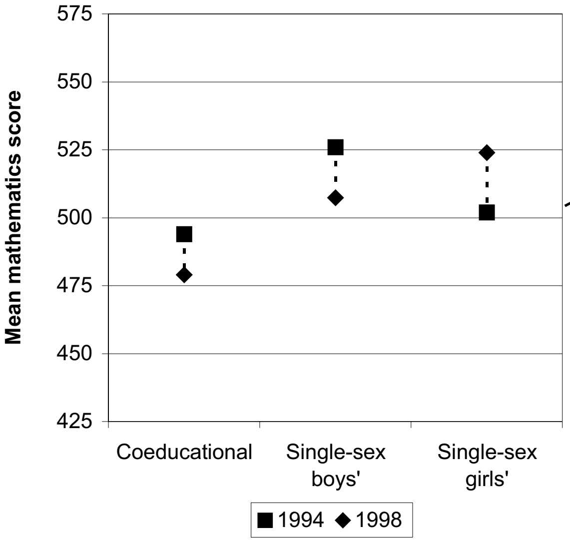
When students' mathematics achievement was examined alongside the type and TFEA decile band of the school they were attending, the school type had less association with achievement than schools' TFEA decile band. When the mathematics performance of the students within schools in either the medium or high TFEA decile bands[11] was compared there were no statistically significant differences in the mean scores of students in different school types. Yet, students in high TFEA decile band schools consistently had statistically significantly higher mean mathematics scores than those in medium TFEA decile band schools of the same school type.

In our second illustration, mathematics achievement is considered alongside school type and a proxy student-level measure of wealth: namely, the Home Education Resources (HER) Index. The HER Index had three levels: high, medium and low. Students assigned to the high level had reported that they came from homes with more than 100 books, with a computer, a study desk for their own use, and a dictionary, and where at least one parent finished university. Students were assigned to the low level of the index had 25 or fewer books in the home, not all three educational aids noted above, and their parents had not completed their secondary education. The remaining students were assigned to the medium level of the index.

When the mathematics performance of the students on the medium level of HER[12] was compared there were no statistically significant differences in the mean scores of students in different school types (after adjusting for multiple comparisons of means). By contrast, students categorised as high on the HER Index consistently had statistically significantly higher mean mathematics scores than those categorised as medium HER within the same school type. In summary, it does not appear that school-type alone should be considered as having the major influence on mathematics achievement, despite the association between the two.

Figure 3.8 presents the trends in Year 9 students mean achievement for 1994 and 1998, by school type. (See Table B.12 in Appendix B for details on 1994.)

FIGURE 3.8: YEAR 9 STUDENTS' MEAN MATHEMATICS SCORES IN 1994 AND 1998, BY SCHOOL TYPE



For students attending each of the school types the difference between mean scores in 1994 and 1998 was not statistically significant.

---

[11] *Around half of students in each of the three school types were in medium TFEA decile band schools (decile 4-7); and between a quarter and a half of students of students in each of the three school types were in high TFEA decile band schools (decile 8-10).*

[12] *Most students within each of the school types (at least two-thirds) fell into the medium HER category.*

THE MATHEMATICS CONTENT REPORTING CATEGORIES

As was the case in TIMSS-94, TIMSS-98 was also able to examine the achievement of students in a number of different areas of mathematics[13]. These content reporting categories, outlined below, originated from the mathematics curriculum framework developed for TIMSS-94/95.

1. *Fractions and Number Sense* — includes whole numbers and integers; common and decimal fractions including their meaning and representation, operations, relations and properties; estimation; and proportionality.
2. *Measurement* — includes concepts of measurement, units of measurement, perimeter, area, and volume, and estimation of measurements.
3. *Data Representation, Analysis, and Probability* — includes interpretation of tables, charts, and graphs, and simple descriptive statistics such as means; simple probability concepts and numerical probability.
4. *Geometry* — includes congruence and similarity; transformations and symmetry; coordinate geometry; points, lines, angles, parallels and perpendiculars; polygons (including triangles and quadrilaterals); and circles.
5. *Algebra* — includes linear equations; algebraic expressions and formulas, linear inequalities, simple linear systems, and number patterns; setting up and solving simple proportionality equations.

For further details see McKnight et al, 1993; Robitaille et al, 1993; and Mullis et al, 2000.

Test Curriculum Matching Analysis

A total of 154 mathematics items in multiple choice and open-ended format were rotated across a total of eight booklets. About one-third of the items were trend items — that is, test questions that were common to both TIMSS-94 and TIMSS-98. The other two-thirds were new items developed to replace the TIMSS-94 items that were released into the public domain in 1997. As noted in Chapter 1, the new items were trialled across all participating countries to ensure that the questions had the same level of difficulty, and required the same type of performance to answer, as the items they were replacing.

As was the case in TIMSS-94/95, a Test Curriculum Matching Analysis was carried out after the test was administered. The purpose of the analysis was to determine which of the final pool of new and trend items were explicitly in the *intended* curriculum for each country.

Using *Mathematics in the New Zealand Curriculum* (Ministry of Education, 1992), the content of 92 percent of mathematics items was judged to be at least at Levels 4 or 5 of the *intended* curriculum, these being the levels at which most Year 9 students would be working. It is important to remember that although the content of an item may have been explicitly stated in the curriculum it does not necessarily mean that all students had been exposed to or taught the content. The converse was also true — that is, students may have been exposed to content that is not explicitly mentioned in or considered peripheral to the intended mathematics curriculum but is covered or used in learning areas other than mathematics. Table 3.9 presents the breakdown by content reporting category.

---

[13] *In the original reporting of TIMSS, there was a separate category for* Proportionality. *However, to enable the calculation of reliable IRT sub-scale scores, the proportionality items were included in either the* Fractions and Number Sense *or* Algebra *reporting categories.*

TABLE 3.9: PROPORTION OF TIMSS-98 MATHEMATICS ITEMS JUDGED TO BE IN THE NEW ZEALAND *INTENDED* CURRICULUM FOR YEAR 9 STUDENTS, BY CONTENT AREA

Content reporting category	Number of items *	Score points^ allocated to each content category	Items in the *intended* curriculum (%)
Fractions & Number Sense	60	62	93
Measurement	21	26	95
Data Representation, Analysis, & Probability	21	22	100
Geometry	21	21	81
Algebra	31	38	87

Notes

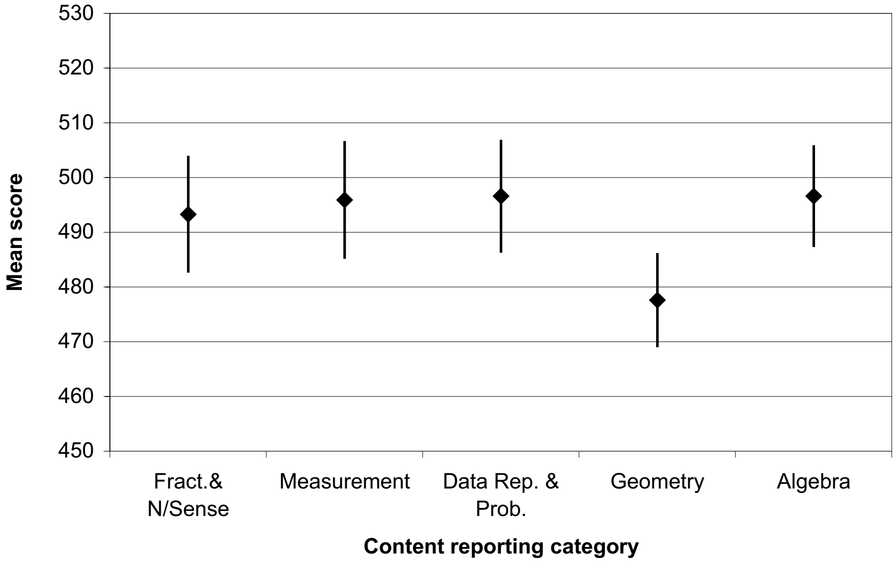
* *Number of items in each reporting category does not reflect the fact that there were different parts to the items. For the Test Curriculum Matching Analysis, the entire item was examined when judging whether or not it was in the* intended *curriculum for NZ Year 9 students.*

^ *Some free-response items were divided into two or three parts; each part of an item was treated as a single item for scoring purposes.*

ACHIEVEMENT IN THE MATHEMATICS CONTENT REPORTING CATEGORIES

As well as calculating an overall mathematics score, Item Response Theory was used to generate sub-scale scores for each mathematics content reporting category. Figure 3.9 shows the mean scores for each content reporting category. (See Table B.13 in Appendix B for details.)

FIGURE 3.9: YEAR 9 STUDENTS' MEAN SCORES FOR EACH MATHEMATICS CONTENT REPORTING CATEGORY IN 1998



The data points are the mean scores. The vertical lines extending from the data point show the 95% confidence interval around the mean, ie, ± 2 standard errors.

As noted previously, the content area scale scores were calculated separately from the overall mathematics score. Because they are independent measures, the means for each content area cannot be compared relative to the overall mean score. In order to ascertain Year 9 students' areas of relative strength and weakness in mathematics, the mean for each content reporting category can be compared to the average of the five sub-scale score means. While Year 9 students achieved, on average, a higher score in *Data Representation, Analysis, and Probability,* essentially in none of mathematics content areas did students' achievement reach a level where it could be said they had a relative strength in that area. *Geometry*, however, appeared to be an area of relative weakness for New Zealand Year 9 students. It is worth noting that a smaller proportion of the *Geometry* items were judged to be in the *intended* curriculum for Year 9 students than was the case for the other areas.[14]

How did Year 9 students' achievements in each area compare with their international counterparts?

To enable the performance in each mathematics content area for a particular country to be examined relative to that of other countries, the international means for each category were set at 487. According to Mullis et al (2000), New Zealand Year 9 students, on average, achieved at around about the international mean for four out of five content reporting categories. The one exception was *Geometry*, where on average, New Zealand Year 9 students achieved slightly lower scores than the international mean. There were no statistically significant differences between each New Zealand sub-scale mean and the comparable international sub-scale mean. (Note that the significance tests were adjusted for multiple comparisons — see TN.5 in Technical Notes).

Mean scores in *Geometry* gained by students from England and the United States were also below the international mean; *Geometry* was also an area of weakness for these students relative to their performance in other mathematics content areas. And while Dutch, Belgium (Flemish), Singaporean, Canadian, and Australian students on average achieved scores in *Geometry* above the international mean, it was also found to be an area of relative weakness for students in these countries. By way of contrast, *Geometry* was area of relative strength in Indonesia, Iran, Morocco, Jordan, and Tunisia.

Gender and achievement in the mathematics content reporting categories

Figure 3.10 presents the mean scores in each mathematics content area by gender (see Table B.13, Appendix B for details). With the exception of *Measurement*, where Year 9 boys, on average, achieved higher scores than Year 9 girls, the mean scores for girls were higher than those for Year 9 boys. The largest difference between mean scale scores was in *Algebra* (about 19 scale score points). This difference was found also to be statistically significant[15]. There were no other statistically significant differences between girls' and boys' mean achievement in the other content reporting areas.

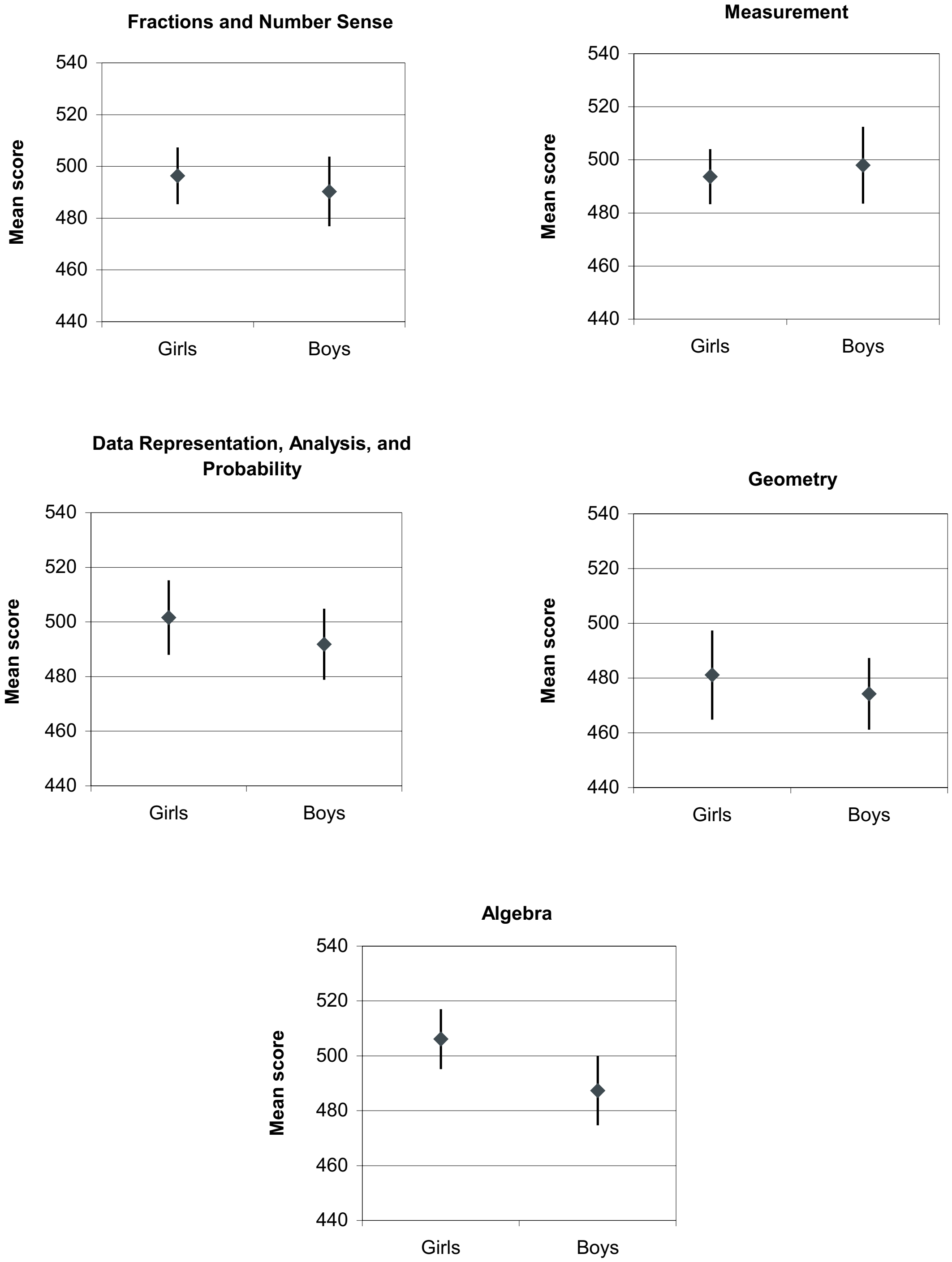
Across countries, there were only two content areas — *Fractions and Number Sense* and *Measurement* — in which boys achieved statistically significantly higher mean scores than girls. While *Algebra* and *Data Representation, Analysis, and Probability* were areas where girls achieved higher mean scores than boys, when adjusted for multiple comparisons the differences were not of statistical significance.

---

[14] *It was not possible to examine differences in achievement from 1994 to 1998 in each of the content reporting categories. This was due to the number of items in reporting each category that were common to both assessments — however, it was possible to look at mean percent correct — see Table B.14, Appendix B for trends in achievement.)*

[15] *The difference between New Zealand girls and boys in* Algebra *was not of statistical significance when the differences across countries were examined for significance (ie, when adjusted for multiple comparisons). See TN.5 in Technical Notes.*

FIGURE 3.10: YEAR 9 STUDENTS' MEAN SCORES FOR THE FIVE MATHEMATICS CONTENT REPORTING CATEGORIES IN 1998, BY GENDER



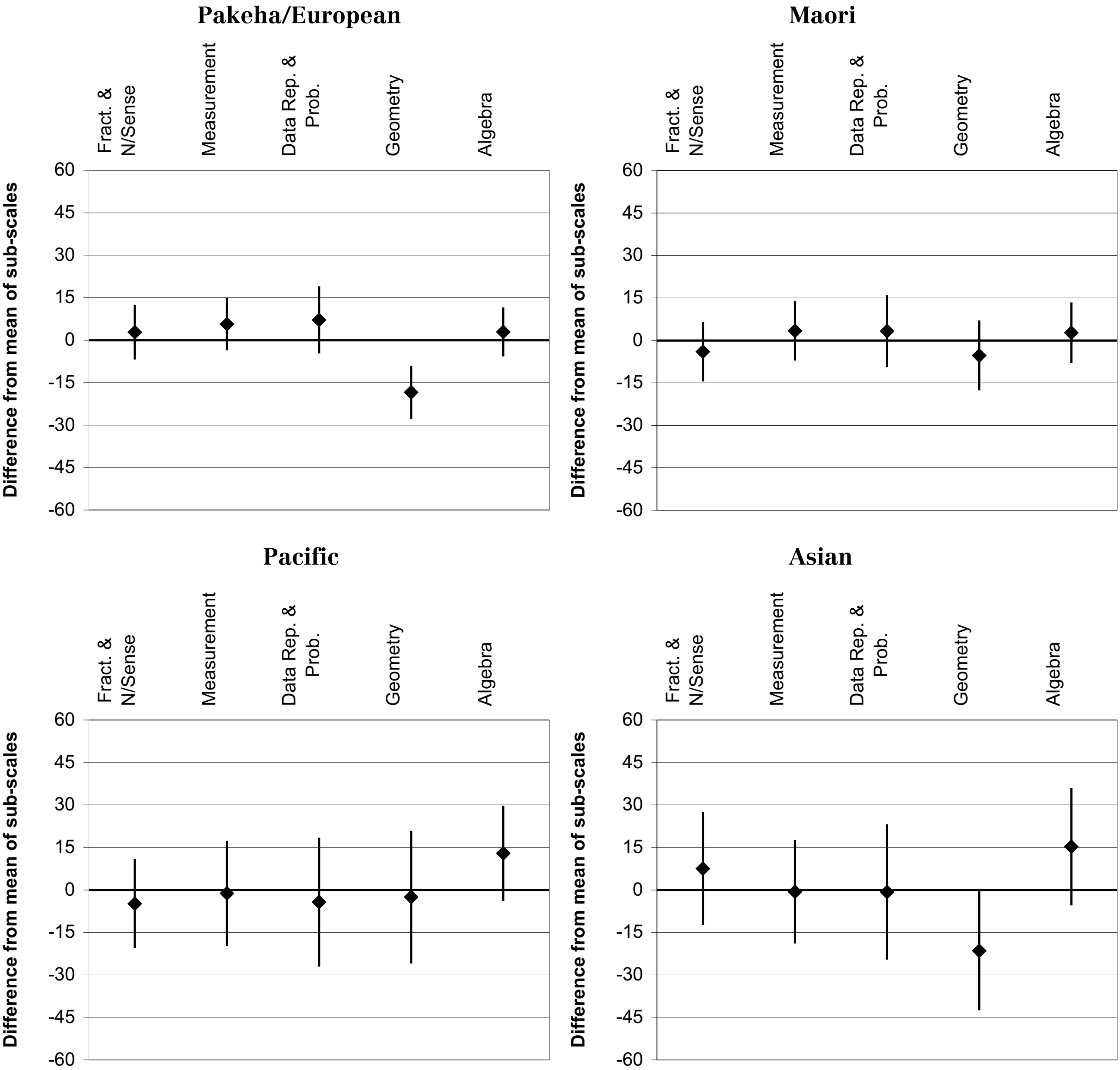
The data points are the mean scores. The vertical lines extending from the data point show the 95% confidence interval around the mean, ie, ± *2 standard errors.*

Ethnicity and achievement in the mathematics content reporting categories

The patterns of achievement in each mathematics reporting area for the four main ethnic groupings reflect the overall achievement pattern in mathematics. That is, Asian students, on average, achieved higher scores than any other ethnic grouping in all mathematics content areas. Similarly, Pacific students achieved scores that were, on average, lower than those of students in the other three main groupings. However, on page 51 it was reported that the area of mathematics in which New Zealand Year 9 students experienced the most success was *Data Representation*, *Analysis, and Probability*, with this being the case for both Pakeha/European and Maori students. As a comparison, the area of relative strength for Pacific and Asian students was *Algebra*. Overall, *Geometry* was found to be an area of relative weakness, particularly for Pakeha/European students.

Figure 3.11 illustrates how each ethnic grouping had their areas of relative strength and weakness. (Also, see Table B.15, Appendix B.)

FIGURE 3.11: RELATIVE STRENGTHS AND WEAKNESSES IN MATHEMATICS CONTENT REPORTING CATEGORIES IN 1998, BY ETHNIC GROUPING



Each data point represents the difference from the mean of the sub-scale scores. The vertical lines extending from the data point show the 95% confidence interval around this point, ie, ± 2 standard errors.

Chapter 3 has focused on trends in Year 9 students' mathematics achievement from 1994 to 1998. This theme continues in Chapter 4 where trends in science achievement is examined.