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NEW ZEALAND

MINISTRY OF EDUCATION
Te Tāhuhu o te Mātauranga

IN FOCUS

ACHIEVEMENT IN MATHEMATICS

INFORMATION KIT: STUDENT ACHIEVEMENT IN NEW ZEALAND

Achievement in mathematics

This monograph analyses student achievement data for mathematics from Year 5 to Year 12 in New Zealand. It uses data gathered during the development of 1,500 assessment tasks from a representative sample of about 25,000 students. These data were collected between 2001 and 2003 for the Assessment Tools for Teaching and Learning (asTTle). The tasks cover the eight major content areas within mathematics (Ell, 2001; Thomas, Holton, Tagg, & Brown, 2003) and were designed to assess curriculum Levels 2 to 6.

The eight content areas were:

- number knowledge
- number operations
- algebra or patterns in number
- geometric operations
- geometric knowledge
- measurement
- statistics
- probability.

FIGURE 1. Distribution of mathematics total scores.

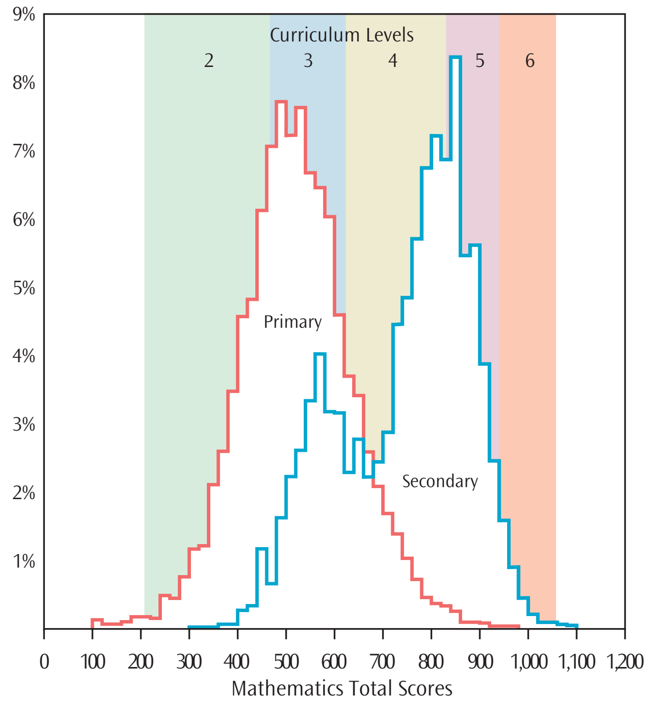
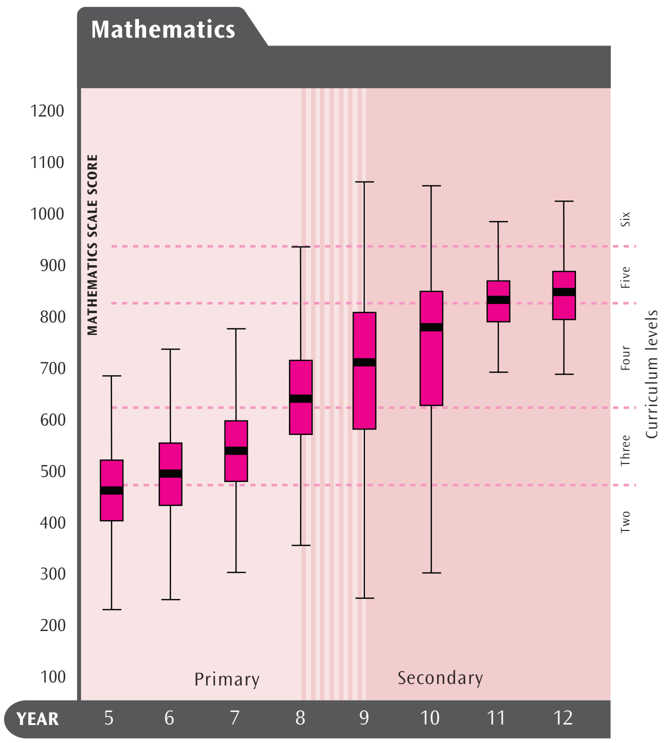


FIGURE 2. Mathematics score and curriculum level by year.



Overall mathematics achievement

The average score across all years in mathematics was 610 or curriculum Level 3 Advanced[1], with the range covering just over 1,000 points (Figure 1). The distribution was slightly bimodal (ie, there were two peaks), with a first peak centred on a score of 550, and a second peak centred on 800. The first peak represented the majority of primary school students (Year 5 to Year 8) who had a median of 520, or curriculum Level 3 Proficient. The second peak comprised mainly secondary students (Year 9 to Year 12) who had a median of 780 or curriculum Level 4 Advanced.

Mathematics achievement across student years

Students' average achievement in mathematics increased with each curriculum year, with an average increase of 62 points from one school year to the next (Figure 2). However, this increase was not constant across all years, with some years showing a more rapid improvement. For example, there was a 100 point gain between Year 7 and Year 8, and an 80 point gain from Year 10 to Years 11/12[2]. While the average for students entering secondary school was at curriculum Level 4 Proficient, about 35% of students were still in Level 3 or below. Level 5 was not achieved, on average, until Years 11/12.

1 The range of scores for each curriculum level is divided into basic, proficient and advanced.

2 As the number of students sampled from Year 12 was low, their data have been merged with Year 11 students for this and subsequent analyses.

Mathematics content areas

Students performed and grew in a similar manner across the eight content areas for mathematics. When average performance in each content area was plotted against year level, they were closely bundled together. The rapid increase in mathematics performance between Year 7 and Year 8 was mostly associated with number knowledge, algebra, statistics, and geometric operations. To examine the differences the eight areas were put into three groupings: number and algebra; geometry and measurement; probability and statistics.

Number and algebra. The three number-related areas were very similar, with regular growth across the years (Figure 3).

Measurement, geometric knowledge and operations. Growth in geometric operations appeared to plateau at Year 9 and there was a similar effect for measurement at Year 10 (Figure 4). In contrast, performance in geometric knowledge was around 60 points higher than the other content areas at Year 5, but declined at Year 6, before increasing again after Year 7.

FIGURE 3. Average mathematics score and curriculum level by year for number knowledge, number operations, and algebra.

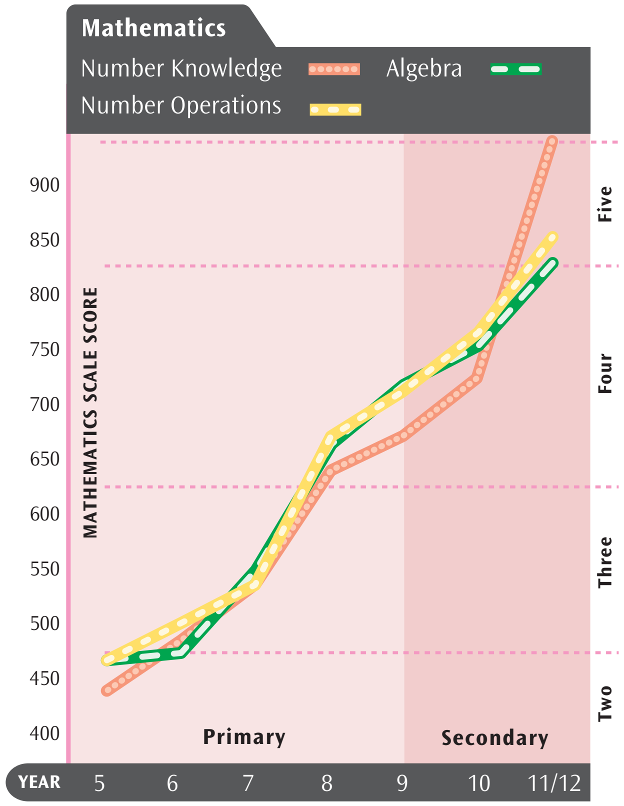


FIGURE 4. Average mathematics score and curriculum level by year for geometric knowledge, geometric operations, and measurement.

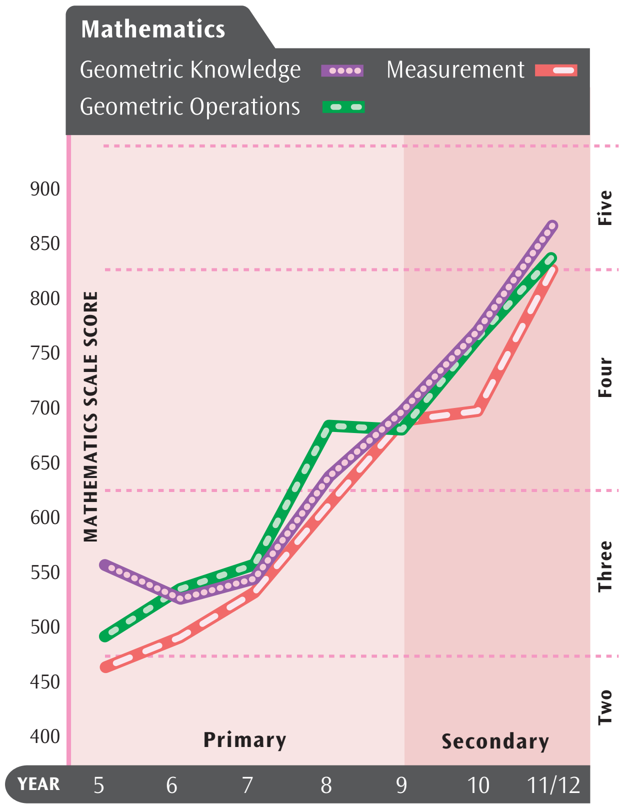


FIGURE 5. Average mathematics score and curriculum level by year for probability and statistics.

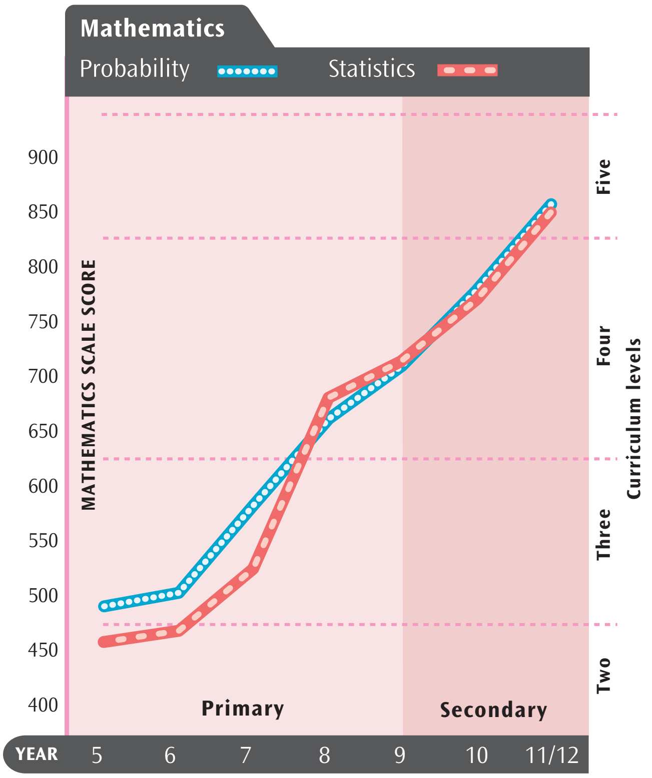
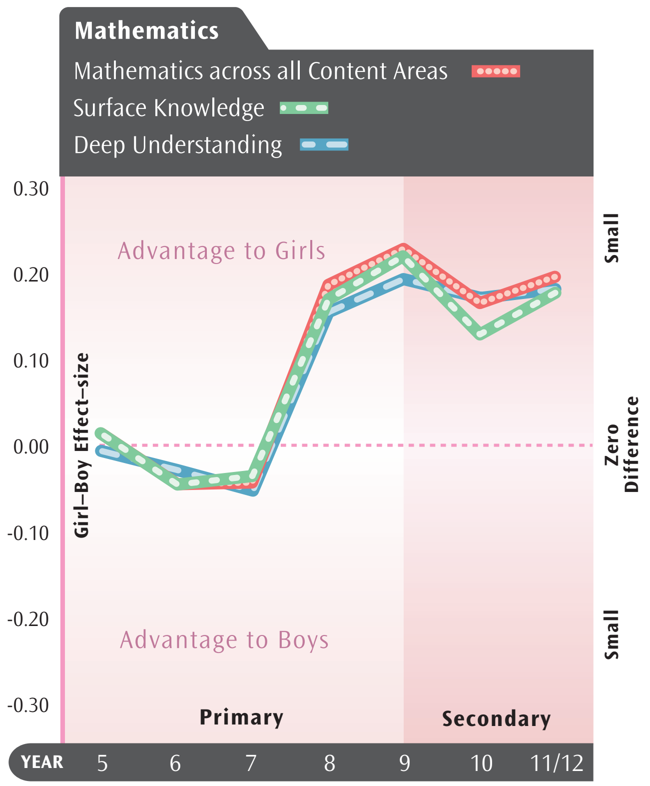


FIGURE 6. Average mathematics score and curriculum level by gender by year.



Probability and statistics. Performance in probability and statistics was closely linked, especially as the curriculum began to focus on these content areas from Year 8 onwards (Figure 5).

Gender

The performance of boys and girls was closely aligned across all the content areas in mathematics, with an average effect size across all years of only 0.10[3]. However, the gap between boys and girls in overall mathematics achievement, both in processing the surface knowledge of facts and steps and in the deep understanding of relationships and principles, increased from Year 8 onwards (Figure 6). Gender differences jumped significantly in favour of girls between Years 7 and 8, and remained in their favour throughout secondary schooling. The effect-sizes were small, however, and it is likely that there are many moderators other than gender that are more important in understanding growth in mathematics.

3 Effect size is a statistical method of taking into account the variation and sample size of the groups whose means you are comparing. An effect size of greater than 0.4 is generally regarded as exceeding the average of all educational interventions.

Ethnicity

Each ethnic group made similar gains in their average mathematics performance from Year 5 to Years 11/12 (Figure 7). However, Māori and Pasifika students started with a lower average score than Pākehā/New Zealand European students and Asian/Other[4] students at Year 5 and this disparity remained at Years 11/12. The rate at which improvement occurred also varied between different years among the different ethnic groups.

For example, Pākehā/New Zealand European and Asian/Other students greatly improved their mathematics performance with a 100 point gain from Year 7 to 8 and a similar increase from Year 8 to 9. Māori students accelerated in mathematics a year later, at the start of secondary school. It was not until Years 11/12 that Pasifika students exhibited the same acceleration in their mathematics learning. The accelerated increase seen overall at Year 8 (Figure 2) does not appear to greatly affect Māori and Pasifika students[5].

English spoken at home

In terms of dominant language at home, students were classified into two categories: those who always or usually spoke English at home, and those who never or sometimes spoke English at home. Primary school students who predominantly used a language other than English at home had lower mathematics achievement than their predominantly English-speaking peers (Figure 8). As students progressed through their primary schooling, however, this gap lessened, and from Year 7 onwards the frequency of English spoken at home had no significant effect on mathematics achievement.

FIGURE 7. Average mathematics score and curriculum level by ethnic group and year.

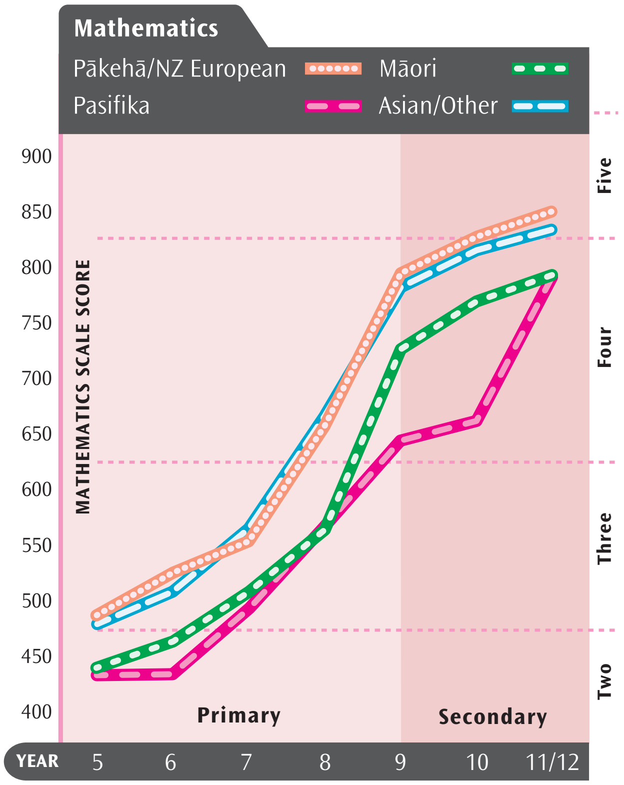
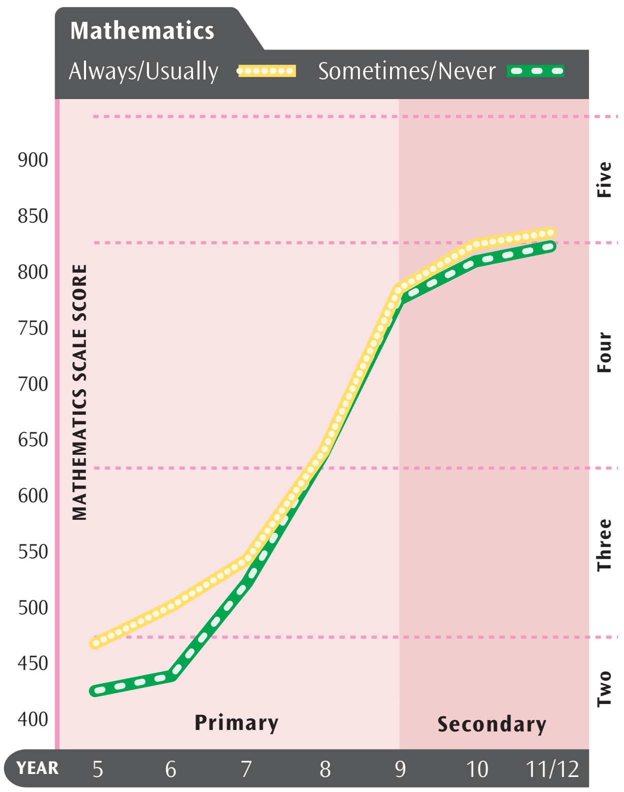


FIGURE 8. Average mathematics score and curriculum level by frequency of English spoken at home and year.



4 Note the number of students reporting themselves as Asian or Other ethnicity was too low to provide robust statistics and so these two categories have been merged.

5 Note the average mathematics score for Pasifika students at Year 8 should be taken cautiously as the sample size was only 74.

FIGURE 9. Average mathematics score and curriculum level across deciles for primary and secondary students.

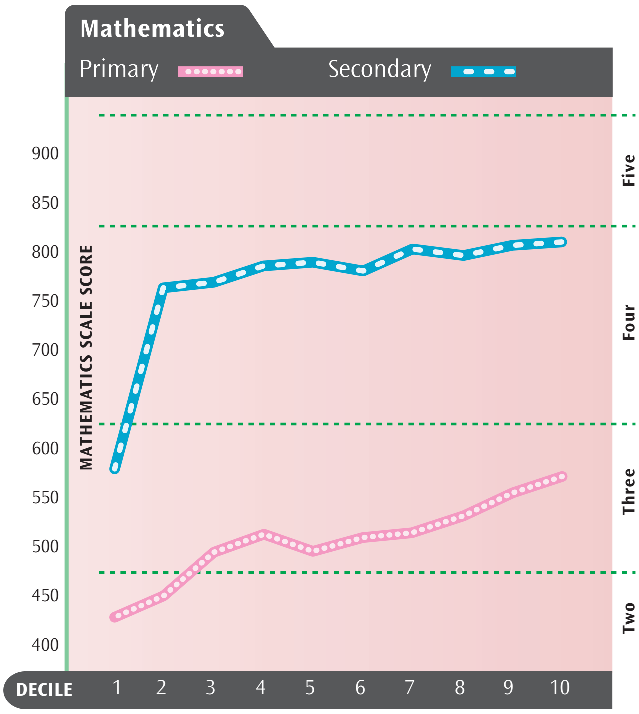
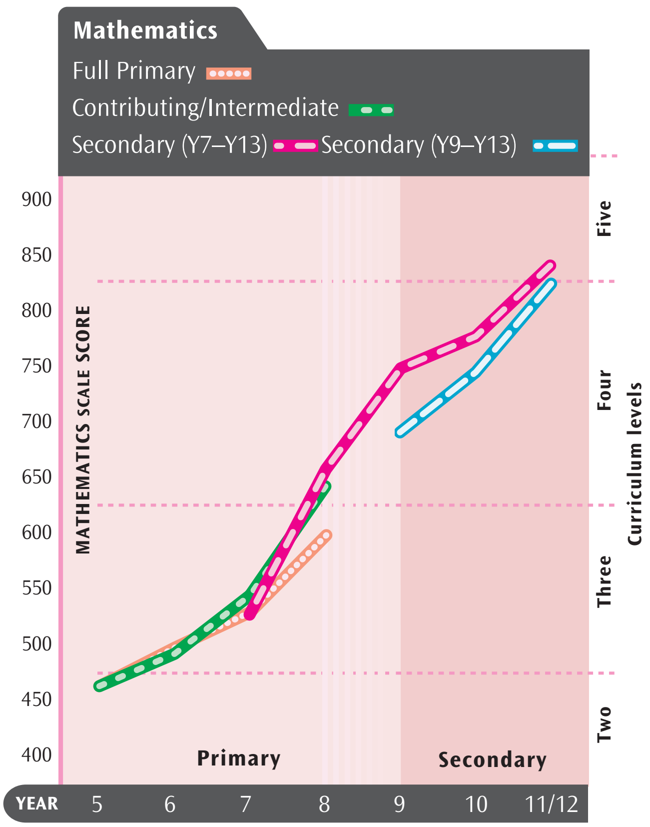


FIGURE 10. Average mathematics score and curriculum level by school type and year.



School decile

By aggregating performance across Years 5 to 8 as primary and Years 9 to 12 as secondary, it was possible to see the relative impact of school decile on student performance in mathematics (Figure 9). The average mathematics achievement between decile 1 and 10 at primary school varied by about 150 points, or from curriculum Level 2 proficient to Level 3 advanced. Decile 1 and 2 schools were, on average, only in Level 2, while the averages for deciles 3 to 10 were within Level 3. Likewise, average mathematics achievement at secondary school did not vary significantly across deciles 2 to 8 (all in Level 4 advanced); decile 1, however, was nearly 200 points behind in Level 3 advanced. Student performance across the other school deciles was relatively similar.

School type

Most of the increase in mathematics achievement between Years 7 and 8 was among students attending intermediate schools (70% of Year 7 students tested, 57% of Year 8 students) and those enrolled in secondary schools with attached intermediate years (secondary Years 7 to 13) (Figure 10). Students in secondary schools with attached intermediate years also had an average mathematics score about 60 points higher at Year 9 than those enrolled in Years 9 to 13 secondary schools.

Conclusion

The main findings were:

- students improved overall in mathematics over their school years, but the average increase was not at the same rate for all years
- achievement in the content areas was closely aligned but different content areas showed accelerated gains at different years
- girls had a slight advantage over boys from Year 8 onwards but the difference was small and probably not educationally significant
- all ethnic groups made similar overall gains in mathematics from Year 5 to Years 11/12, but Māori and Pasifika students started with a lower average score and the gap remained throughout the years
- speaking English at home most or all of the time showed a small advantage at primary school, but not at secondary school
- there were significant differences in achievement between the highest and lowest decile schools but little difference in achievement between schools in deciles 3 to 9
- students in Year 7 to 13 schools and intermediates produced higher average mathematics achievement scores than those in full primary schools.

As the increase in average mathematics achievement was not equal across student years, improvement did not appear to be simply a result of a steady accumulation of knowledge and skills. Although Māori and Pasifika students were collectively behind Pākehā and Asian/Other students, they showed the same steep acceleration in their learning ability – although at different times to Pākehā and Asian/Other students. A closer examination of the factors that produced these accelerations in achievement of Māori and Pasifika students, and introducing them earlier, may help to close this achievement gap.

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Ell, F. (2001). ***Mathematics in the New Zealand Curriculum – A concept map of the curriculum document***. Project asTTle Technical Report 11. University of Auckland/Ministry of Education.

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Thomas, G., Holton, D., Tagg, A., & Brown, G. T. (2003). ***Mathematics curriculum framework and map: Levels 2-6***. Project asTTle Technical Report 36. University of Auckland/Ministry of Education.

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