Te Poutama Tau Student Performance in asTTle

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This study examines whether students participating in Te Poutama Tau transfer their knowledge to solving problems that differ in form and context. Additionally, it examines how these students perform in traditional written-type tests, in particular the asTTle test[1], against the national norms for Māori-medium schools. An asTTle test was given to one cohort of year 4 and one of year 7 students who had participated in Te Poutama Tau, and the results were compared with those of a previous study[2]. In this test, both cohorts of students performed above the national norm for Māori-medium schools on number knowledge items. However, across all test items, both the 2007 and 2008 year 4 cohort performed below the national norms for Māori-medium schools. On the other hand, both the 2007 and 2008 year 7 cohorts performed above or close to the national norms for Māori-medium schools, although not noticeably so in algebra.

Background

Initiated as a pilot in 2002, Te Poutama Tau is the Māori-medium component of a key government initiative aimed at raising student achievement by building teacher capability in teaching and learning numeracy in schools (Christensen, 2003). Te Poutama Tau acknowledges professional development as a key to integrating theory and practice for quality outcomes in Māori-medium mathematics (pāngarau) education (Trinick & Stevenson, 2006, 2007). By improving the professional capability of teachers, students' performance in numeracy is also improved (Christensen, 2003). The Number Framework (Te Mahere Tau) is central to Te Poutama Tau. It outlines for teachers the stages of number knowledge and the operational strategies through which students progress in their learning of number (Ministry of Education, 2007a). Students are assessed against the stages of Te Mahere Tau using a diagnostic interview (Te Uiui Aromatawai, Ministry of Education, 2007b), which stresses conceptual understanding and students' internal construction of mathematical meanings (Trinick & Keegan, 2008).

Research to date based on the data from diagnostic interviews indicates that Te Poutama Tau has improved outcomes for students (Trinick & Stevenson, 2005, 2006, 2007, 2008). This study examines whether Te Poutama Tau students transfer their knowledge to solving problems that differ in form and context. Additionally, it examines how these students perform in traditional written-type tests, in particular the asTTle (Assessment Tools for Teaching and Learning [He Pūnaha Aromatawai mō te Whakaako me te Ako]) test, against the national norms for Māori-medium schools. As a result of an earlier Te Poutama Tau/asTTle study, questions arose as to the validity of the asTTle norms for Māori-medium schools and whether the students' results in that study would be consistent with those in future studies (Trinick & Keegan, 2008).

AsTTle is an educational resource for assessing literacy and numeracy (in both English and Māori). It provides teachers, students, and parents with information about a student's level of achievement, relative to curriculum achievement outcomes[3], for levels 2–6 and national norms of performance for

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1 asTTle: Assessment Tools for Teaching and Learning (He Pūnaha Aromatawai mō te Whakaako me te Ako)

2 Trinick & Keegan, 2008

3 The asTTle tests used in this study were based on the 1992 *Mathematics in the New Zealand Curriculum* (Ministry of Education, 1992). All references in this paper to the curriculum or to curriculum strands are to this 1992 curriculum document.

students in years 4–12. Teachers can use asTTle to create "paper-and-pencil" tests of 40- to 50-minute duration, which means that students must be able to read and write. After the tests are scored, the asTTle tool generates interactive graphic reports that allow teachers to analyse their students' achievement against curriculum levels, curriculum objectives, and population norms (for example, see figures 1 and 2 in this paper).

Aims of the Research

This study examined:

- What aspects of the asTTle test did Te Poutama Tau students perform well in and what were the gaps and areas of weakness?
- How do Te Poutama Tau students' asTTle data compare with the asTTle national norms for Māori-medium schools?
- How do these results compare with the students' performance in the 2007 study?

Method

Participants

Two schools agreed to participate in the 2008 study; one was from a large city and the other was from a small rural town. Both schools had recently participated in Te Poutama Tau. The aim was to replicate the 2007 study as closely as possible, so it was decided to continue focusing on year 4 and year 7 students.

In the 2007 study, year 4 students had been selected because this is the youngest cohort that can be reliably tested using asTTle. Additionally, earlier Te Poutama Tau studies showed a considerable dip in student progress that began in year 3 (Trinick & Stevenson, 2006, 2007). Why this was so is not entirely clear. A number of reasons were considered, including the fact that this is the age group where students are possibly moving towards part–whole thinking. It is also the age group where students may be exposed to a change in teaching pedagogy as they move from years 1–2 to years 3–4 (Trinick & Stevenson, 2007).

The 2007 year 7 cohort had been chosen to provide a comparison with year 4 for showing differences and similarities. Also, schools could use the data when the students were in year 8 to focus on gaps and areas of weakness before the students went on to wharekura (Māori-medium secondary schools) or to English-medium secondary schools.

The Test

An asTTle test focusing on number was generated for each year group in the study, and test scripts were sent out to schools for trialling. The two tests consisted of 32 test items, which were selected to cover number items from the Number and Algebra strands. The aim of the testing was to gain maximum information on students' performance on number and other items relevant to Te Poutama Tau. The nature of asTTle is such that individual test items cannot be selected without losing the capability of the asTTle tool to generate national norms (because norms are not available for individual test items) and associated data. The items in the 2008 test were not identical to those in the 2007 test, but both tests included test items that linked to the same Number and Algebra achievement outcomes in the curriculum. Measurement items were not included in the 2008 test; these were replaced by extra Number and Algebra test items because Te Poutama Tau has tended to focus on these two strands of the curriculum.

The test scripts returned by each participating school were marked, and then a report was compiled for each school. This report included four major reports for teachers, each of which provided different analyses of each year group. These analyses included:

- comparing student performance against a nationally representative Māori-medium sample;
- comparing student performance in relation to curriculum levels and difficulty;
- identifying curriculum outcomes that students had or had not achieved and which of these the students showed strengths in or revealed gaps or areas of weakness;
- allocating each student in a particular curriculum level as being either at the beginning, proficient, or advanced stages.

This report was ideal for assisting teachers to group their students.

AsTTle Tests: Results

All results reported in this section are based on the aggregated results of the 2008 year 4 and year 7 students and are displayed using three types of reports. The results are compared with those from 2007 to identify patterns in achievement.

The Reports

The asTTle reports are primarily aimed at answering the feedback question "How are Te Poutama Tau students doing in comparison with similar students in Māori-medium settings nationally?" AsTTle answers this question by providing comparative or normative information for the group of students in this sample.

Group Performance

Student achievement by year is shown in box-and-whisker plots that display both the national Māori-medium norms and the distribution of the student scores. The reports show the average of the year group and the range of achievement of that group. The box-and-whisker plots are based on five score points (top score, upper quartile, median, lower quartile, and bottom scores) attained by students participating in the test. The white box plot represents the performance of the 2008 Te Poutama Tau students, and the shaded plot represents the performance of the year 4 and year 7 national Māori-medium reference population. Groups that have short ranges within the box and/or the whiskers are more similar in their performance than those with wide ranges. Groups whose median scores are at the top or bottom of the reference group box (the student cohort in this study) probably differ from the national Māori-medium norm by more than chance.

Curriculum Functions

This report shows the aggregated results for each strand of the curriculum that was selected for these particular tests. In the tests generated for this 2008 study, only test items from the Number and Algebra strands were included (as noted earlier).

Learning Pathways Report

These reports were identified by generating learning pathway reports to answer the question "What are the strengths and weaknesses of student performance in regard to the curriculum outcomes?" A percentage is given of the student cohorts that were identified as having achieved/not achieved

or as having strengths/gaps in regards to the curriculum outcomes. For this report, "achieved" and "strengths" have been aggregated and are reported under performance highlights. This is where more than 60% of the cohort was identified as having achieved and showed strengths in this outcome. "Not achieved" and "gaps" are aggregated as performance concerns. This is where more than 60% of the cohort was identified as having not achieved and as having gaps in their knowledge.

Comparison of the 2007 and the 2008 Year 4 Students

Results of the Year 4 students

Group performance

The aggregated data of all the 32 test items shows the average of the year group and the range of achievement of the group. Figure 1 shows that the 2008 year 4 Te Poutama Tau students' median in this study was slightly below the norm for students in Māori-medium schools. However, this is an improvement on the 2007 results, which were approximately 200 points below the national Māori-medium norm (Trinick & Keegan, 2008). The results for both these cohorts were not expected. The national Māori-medium norms were established before the implementation of Te Poutama Tau, so it was assumed that, because Te Poutama Tau predominately focuses on Number and, to a lesser degree, Algebra, these Te Poutama Tau students would generally perform better than the national Māori-medium norms in these two strands of the curriculum.

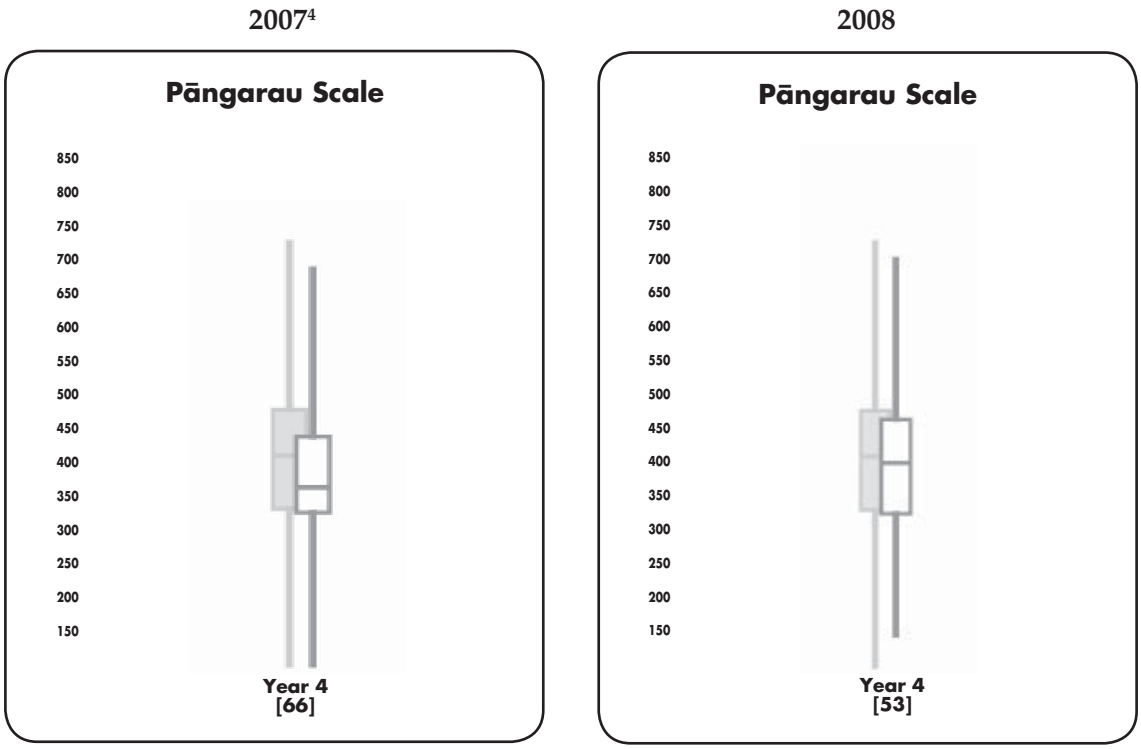

Figure 1. Group performance of year 4 students in 2007 and 2008

Curriculum functions report

Figure 2 shows that the 2008 year 4 students were slightly above the national Māori-medium norm in Number and below for Algebra. Again, this is an improvement on the 2007 results, where students were close to the national Māori-medium norm in Number but were substantially below the national Māori-medium norm in Algebra.

[4] See the explanation on page 15 of the shadings of the box plots.

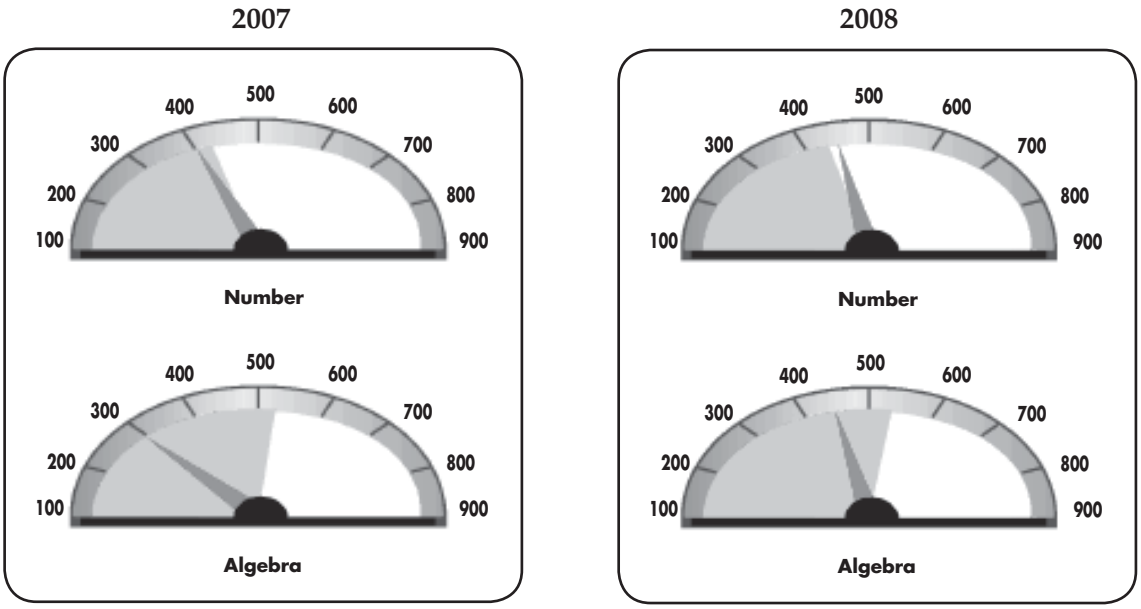

Figure 2. Year 4 student performance in the strands of the curriculum

Learning Pathways Report for Year 4

Performance highlights

Number

The year 4 students in the 2008 study performed positively in the questions that involved ordering whole numbers and decimals. Similarly, student results were positive in questions that required recalling basic facts for addition and subtraction. Number word sequencing and basic facts are both key components of the knowledge domain of Te Mahere Tau in Te Poutama Tau.

Performance concerns

Number

The 2008 year 4 students performed poorly in the questions that involved writing and solving whole- and decimal-number word-story problems with combinations of +, –, x, and ÷. This gap in achievement is consistent with the 2007 results.

Algebra

Both the 2007 and 2008 cohorts of year 4 and year 7 students performed poorly in most of the Algebra questions, including using the mathematical symbols =, <, and >. These also included questions that required entering either the correct symbol or quantity to show a relationship. For example, students were required to enter either <, >, or = in the box to show the appropriate relationship between 80 and 90 (80 ☐ 90) and the relationship between the multiplication pairs 9 x 2 and 6 x 3 (9 x 2 ☐ 6 x 3). They also needed to enter the quantity missing in the box in ☐ + 8 < 10.

Making, describing, and using rules for number and spatial patterns is also an area where a substantial number of 2008 students were below the national Māori-medium norm.

Results of the Year 7 Students

Group performance

Both the 2007 and 2008 year 7 Te Poutama Tau students performed noticeably better than the national Māori-medium norm (Figure 3). The range of performance is much narrower in 2008, suggesting

that most of the Te Poutama Tau students in this 2008 study were closer in ability to the national Māori-medium norm.

In the 2007 results, the top scores are off the scale and are much higher than the national Māori-medium norm (Trinick & Keegan, 2008). Notably, in both years there is no long tail of low scores in the Te Poutama Tau cohort.

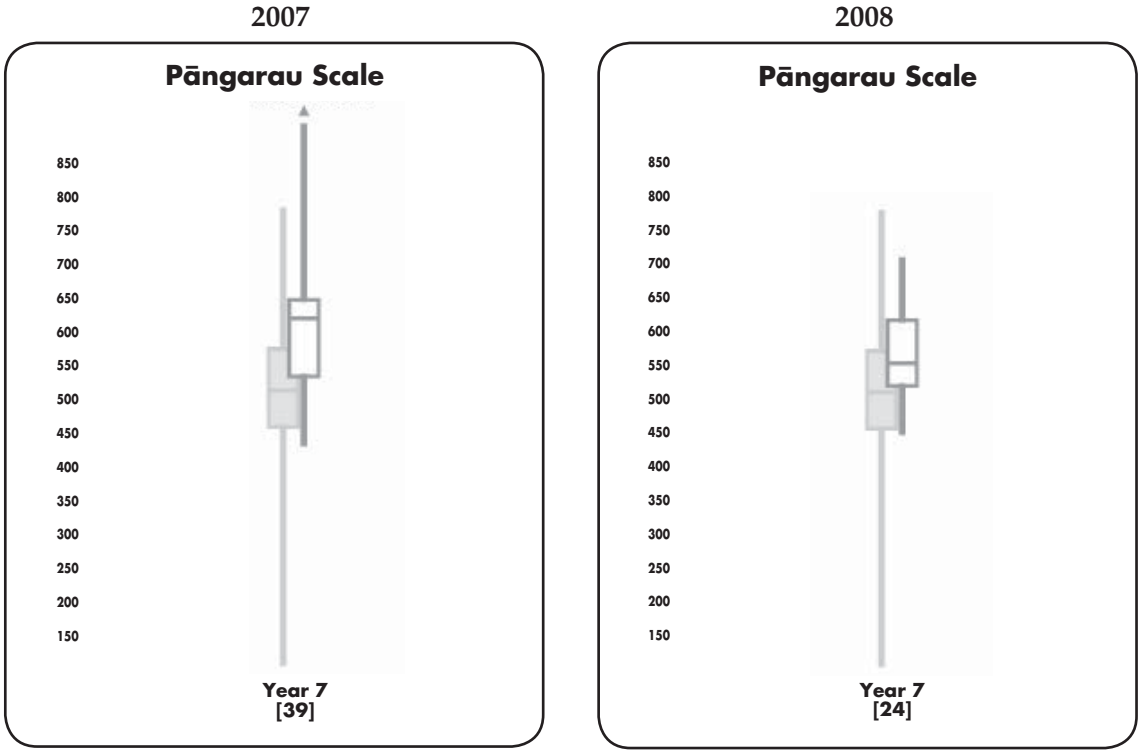

Figure 3. Group performance of year 7 students in 2007 and 2008

Curriculum functions report

In number, both the 2007 and 2008 year 7 cohorts performed well above the national Māori-medium norms. However, performance in algebra was not noticeably different from the national Māori-medium norms for either cohort. As noted in the 2007 study (Trinick & Keegan, 2008), algebra seems to be an area that students find challenging.

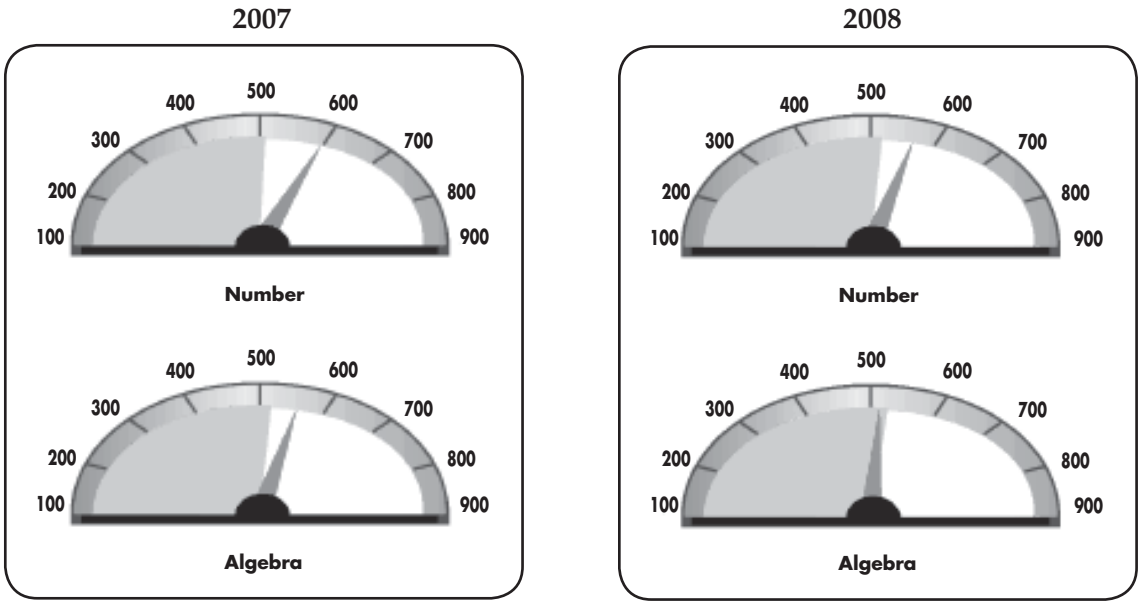

Figure 4. Year 7 student performance in the strands of the curriculum

Learning Pathways Report

Performance highlights

Number

The 2008 year 7 Te Poutama Tau students in this study performed well above the national Māori-medium norms in the questions that involved recalling the basic addition/subtraction and multiplication/division facts. The Te Poutama Tau students also performed particularly well in explaining the meaning of digits in two- to three-digit whole numbers, in expressing quantities as fractions or percentages of a whole, and in finding a fraction or percentage of a quantity. These performance highlights are also consistent with results for the year 7 Te Poutama Tau students in the 2007 study (Trinick & Keegan, 2008). A major focus is given to understanding and developing mental strategies in Te Poutama Tau to solve these types of problems, so this is a very positive outcome.

Algebra

The 2008 cohort of year 7 students performed slightly below the national Māori-medium norm, which is positive considering the year 4 results. The students performed well in questions linked to the learning outcomes, such as continuing sequential patterns.

Performance concerns

Number

The 2008 cohort of year 7 students had some difficulty explaining the meaning of digits in numbers to two or three decimal places, writing and solving problems with decimals in multiplication and division, and using and explaining the meaning of negative numbers. The latter two areas of difficulty are consistent with the 2007 results.

Algebra

About 50% of the 2008 year 7 cohort still had some difficulty with the mathematical symbols =, <, and >. This is discussed in the following section.

Discussion and Concluding Comments

The performance of the year 4 Te Poutama Tau students may be explained partly by fewer years of involvement in Te Poutama Tau. The positive performance highlights that are consistent with Te Poutama Tau include:

- reading and sequencing whole and decimal numbers;
- knowledge of addition and subtraction basic facts.

Some of the areas of concern for students in both the 2007 and 2008 cohorts include the use of the mathematical symbols =, <, and > and being able to describe or make up and use a rule to create a sequential pattern.

The performance of the year 7 Te Poutama Tau students in this study and in the 2007 study is very encouraging. Both cohorts performed above or close to the national Māori-medium norms. The positive results may be due to a range of variables, including teacher effectiveness or participation in other types of interventions such as literacy programmes. Notably, the majority of the year 7 Te Poutama Tau students had participated in Te Poutama Tau for a few years. The positive performance highlights that are consistent with Te Poutama Tau include:

- recalling basic addition, subtraction, and multiplication facts;
- reading and sequencing whole and decimal numbers.

An area of weakness for both the 2007 and 2008 cohorts were test items that involved negative numbers. This can be partly explained by the absence of material in Te Mahere Tau focusing on negative numbers. This is an area for future development. There is a similar issue with solving word problems that involve a variety of operations. Unfortunately, the asTTle test results do not reveal a student's ability to solve problems using mental strategies, which is a feature of Te Poutama Tau.

The year 4 and year 7 groups in both years of the Te Poutama Tau/asTTle study had some difficulty using the mathematical symbols =, <, and >. To learn algebra, students need a conceptual understanding of the use of symbols and the contexts in which they occur (Hiebert, Carpenter, Fennema, et al., 1997). Arcavi (1994, p. 24) introduced the notion of "symbol sense" as a "desired goal for mathematics education". Symbol sense incorporates the ability to appreciate the power of symbols and an ability to manipulate and make sense of symbols in a range of contexts. The concept of equality, for example, is an important idea for developing algebraic concepts among learners of algebra (Carpenter, Franke, & Levi, 2003). This should be an additional area for consideration by the Te Poutama Tau facilitators in 2009 and 2010.

In summary, the 2008 year 4 Te Poutama Tau students performed below the national Māori-medium norms, while the 2008 year 7 Te Poutama Tau students mainly performed above. Why the two age groups performed differently with regard to the asTTle national Māori-medium norms is not entirely clear. However, both the 2007 and 2008 cohorts performed reasonably consistently in a number of areas, particularly in those areas that are a major component of Te Mahere Tau in Te Poutama Tau. These include number knowledge areas such as basic facts. A significant component of Te Poutama Tau is the development of student mental strategies to solve problems. Pencil-and-paper tests such as asTTle are limited in assessing this aspect.

Ko te kōrero whakamutunga, ko te mihi ki ngā ākonga me ngā kura i uru mai ki tēnei rangahau. Nā reira, tēnei te tino mihi atu ki a rātau ko ngā pouako.

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