

2 Assessing Mathematics



The aims of mathematics education, like those of other learning areas, are developed and shaped to reflect understandings and processes that are meaningful, important and useful to individuals and society. Just as knowledge expands, circumstances alter and needs change with time, so too is the content and structure of mathematics programmes adjusted and refined from time to time to reflect current needs and future visions for learners. Expecting students to get the right answers in the shortest possible time with the least amount of thinking is no longer a prime goal of mathematics education. For most students a major aim is to help them develop attitudes and abilities to be flexible, creative thinkers who can cope with open-ended, real-world problems. This requires them to become confident in their understanding and application of mathematical ideas, procedures and processes.



Because much conceptual knowledge and skill in mathematics takes time to develop, fundamental ideas introduced at the early years of schooling are repeatedly elaborated on and extended as students progress through their years at school. It is appropriate, therefore, that assessment in mathematics includes a substantial proportion of tasks which allow us to observe the extent of progress in conceptual knowledge and skill over time.

Although conceptual understanding is clearly one of the major goals of mathematics education, students' capacity for exploring, applying and communicating their mathematical understandings within real-world contexts is also important. Mathematics education is very much concerned with such matters as students' confidence, interest and inventiveness in working with a range of mathematical ideas. The NEMP assessment framework recognises



this by making provision for students to demonstrate their mathematical skills through a range of situations which involves them in asking questions, making connections, and applying understandings and processes to novel, as well as familiar, situations. Although the place for assessing confidence and efficiency in basic mathematical facts is recognised in NEMP assessments, there is also a substantial focus on thinking, reasoning and problem-solving skills that require more open tasks that allow students to demonstrate their number sense, reason, make decisions and explain.



Framework for Assessment of Mathematics

National monitoring task frameworks are developed with the Project's curriculum advisory panels. These frameworks have two key purposes. They provide a valuable guideline structure for the development and selection of tasks, and they bring into focus those important dimensions of the learning domain which are arguably the basis for valid analyses of students' skills, knowledge, understandings and attitudes.

The assessment frameworks are intended to be flexible and broad enough to encourage and enable the development of tasks that lead to meaningful descriptions of what students know and can do. They are also designed to help ensure a balanced representation of important learning outcomes.

The mathematics framework has a central organising theme and four areas of content linked to eight processes. Key aspects of content are listed under each heading and attention is drawn in the final section of the framework to the importance of students' attitudes and motivation.

The most important message emerging from the use of the framework is the pervasive interrelatedness that exists among mathematics content, processes and attitudes. To regard each as a discrete entity of learning, whether for teaching or assessment purposes, assumes clear-cut boundaries that frequently do not exist. In developing and administering tasks, it was sometimes difficult to assign tasks specifically to one aspect rather than another. However, for purposes of reporting assessment information, tasks were allocated to particular categories according to the balance of emphasis. The results are arranged in chapters according to the content areas.



NEMP MATHEMATICS FRAMEWORK	
Confident mathematical and statistical thinking and application of ideas, procedures and processes	
CONTENT	PROCESSES
NUMBER & ALGEBRA <ul style="list-style-type: none"> properties/principles of number operations patterns, relationships and generalisations number knowledge number strategy symbols, equations, graphs and diagrams 	<ul style="list-style-type: none"> making sense and finding connections posing questions and solving problems visualising and representing using and interacting with technologies reflecting and communicating estimating and being precise seeking patterns and generalising explaining and justifying
MEASUREMENT <ul style="list-style-type: none"> systems of measurement and their use selecting and using measuring devices measurement sense issues of measurement and accuracy 	
GEOMETRY <ul style="list-style-type: none"> shape and space position and orientation transformation 	ATTITUDES AND MOTIVATION <ul style="list-style-type: none"> – Valuing – – Perseverance – – Interest and enjoyment – – Confidence and willingness to take risks – – Voluntary engagement –
STATISTICS <ul style="list-style-type: none"> collection, organisation, display and interpretation of statistical data estimation of probabilities and use of probabilities for prediction critical interpretation of others' data 	

The Choice of Tasks for National Monitoring

The choice of tasks for national monitoring is guided by a number of educational and practical considerations. Uppermost in any decisions relating to the choice or administration of a task is the central consideration of validity and the effect that a whole range of decisions can have on this key attribute. Tasks are chosen because they provide a good representation of important knowledge and skills, but also because they meet a number of requirements to do with their administration and presentation. For example:

- Each task with its associated materials needs to be structured to ensure a high level of consistency in the way it is presented by specially trained teacher administrators to students of wide-ranging backgrounds and abilities, and in diverse settings throughout New Zealand.
- Tasks need to span the expected range of capabilities of year 4 and 8 students and to allow the most able students to show the extent of their abilities while also giving the least able the opportunity to show what they can do.
- Materials for tasks need to be sufficiently portable, economical, safe and within the handling capabilities of students. Task materials also need to have meaning for students.
- The time needed for completing an individual task has to be balanced against the total time available for all of

the assessment tasks, without denying students sufficient opportunity to demonstrate their capabilities.

- Each task needs to be capable of sustaining the attention and effort of students if they are to produce responses that truly indicate what they know and can do. Since neither the student nor the school receives immediate or specific feedback on performance, the motivational potential of the assessment is critical.
- Tasks need to avoid unnecessary bias on the grounds of gender, culture or social background while accepting that it is appropriate to have tasks that reflect the interests of particular groups within the community.



National Monitoring Mathematics Assessment Tasks and Survey

One hundred mathematics tasks were administered, together with an interview questionnaire that investigated students' interests, attitudes and involvement in mathematics.

Twenty-seven tasks were administered in one-to-one interview settings, where students used materials and visual information. One task was presented in a team situation involving small groups of students working together. Thirty-two tasks were attempted in a stations arrangement, where students worked independently on a series of tasks, some presented on laptop computers. The final 40 tasks were administered in an independent approach, where students sat at desks or tables and worked through a series of paper-and-pencil tasks.

Twenty-six of the tasks were identical for year 4 and year 8 students. Three tasks were slightly modified between year 4 and year 8. A further 20 tasks included common components for both years, together with more challenging components for year 8 students and, in two cases, less demanding components for year 4 students. Of the remaining tasks, 12 were specifically for year 4 students and 39 for year 8 students. Eleven of these single-year tasks had some parallel or identical components at the two levels.



Access Tasks

Teachers and principals have expressed considerable interest in access to NEMP task materials and marking instructions, so that they can use them within their own schools. Some are interested in comparing the performance of their own students to national results on some aspects of the curriculum, while others want to use tasks as models of good practice. Some would like to modify tasks to suit their own purposes, while others want to follow the original procedures as closely as possible. There is obvious merit in making available carefully developed tasks that are seen to be highly valid and useful for assessing student learning.



Some of the tasks in this report cannot be made available in this way. Link tasks must be saved for use in four years' time, and other tasks use copyright or expensive resources that cannot be duplicated by NEMP and provided economically to schools. There are also limitations on how precisely a school's administration and marking of tasks can mirror the ways that they are administered and marked by the Project. Nevertheless, a substantial number of tasks are suitable to duplicate for teachers and schools. In this report, these access tasks are identified with the symbol above. These tasks are bundled into access kits and can be purchased online, from the NEMP website (<http://nemp.otago.ac.nz>). Teachers are also encouraged to use the website to view tasks and results.



Trend Tasks

Forty-six of the tasks were previously used in the 2005 mathematics assessments. These were called link tasks in the 2005 report, but were not described in detail to avoid any distortions in the 2009 results that might have occurred if the tasks had been widely available for use in schools since 2005. In the current report, these tasks are called trend tasks and are used to examine trends in student performance: whether they have improved, stayed constant or declined over the four-year period since the 2005 assessments. Further trend information comes from two tasks previously used in the 1997 assessments, and from two tasks used in both the 2001 and 2005 assessments.

Link Tasks

To allow comparisons between the 2009 and subsequent assessments, 45 of the tasks used in 2009 have been designated link tasks. Results of student performance on these tasks are presented in this report, but the tasks are described only in general terms because they may be used again in a future study.

Marking Methods

The students' responses were assessed using specially designed marking procedures. The criteria used had been developed in advance by Project staff, but were sometimes modified as a result of issues raised during the marking. Tasks that required marker judgement and were common to year 4 and year 8, or to 2009 and earlier assessment years, were intermingled during marking sessions, with the goal of ensuring that the same scoring standards and procedures were used for both.

Task-by-task Reporting

National monitoring assessment is reported task by task so that results can be understood in relation to what the students were asked to do.

