

# Assessment Framework for the 2004 National Assessment of Mathematical Achievement (NAMA): *Fourth Class*

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## Introduction: What is the Purpose of this Document?

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The purpose of this document is to provide background information on the 2004 National Assessment of Mathematics Achievement in Fourth class, which is to be administered to pupils in a representative sample of primary schools in May, 2004.

## What is the Background to the 2004 Assessment?

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National Assessments of Mathematics Achievement have been conducted as follows:

- 1977 – Second and Fourth classes
- 1979 – Sixth class
- 1984 – Sixth class
- 1999 – Fourth class

Each assessment involved a nationally-representative sample of pupils taking a curriculum-based test of mathematics. In more recent surveys, the pupils, their teachers and their parents, completed short questionnaires that provided contextual information with which to interpret achievement outcomes. A list of reports on these assessments is given in the **references** section at the end of this document.

In addition to these national assessments, Irish pupils have participated in several international assessments in recent years, including:

- the First International Study of Educational Progress in Mathematics and Science (IAEP 1) in 1988, involving 12-year olds (pupils in sixth class, primary level, and first- and second years, post-primary level)
- The Second International Study of Educational Progress in Mathematics and Science (IAEP II) in 1991, involving 9-year olds (third and fourth classes, primary level) and 13-year olds (first- and second years, post-primary)
- The Third International Mathematics and Science Study in 1995 involving 9-year olds (third and fourth classes, primary level) and 13-year olds (first and second years, post-primary level)

These assessments, which involved the administration of tests of achievement in mathematics (and also science) to representative national samples of pupils, allowed for comparisons between the performance of Irish pupils and their counterparts in other countries. Again, a list of reports on these assessments may be found in the **references** section below.

## **What are the Terms of Reference of the 2004 Assessment?**

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The Department of Education and Science asked the Educational Research Centre to conduct a national assessment of mathematics achievement in 2004. Specifically, the Centre was asked to:

1. Conduct a study of the mathematics achievements of a representative national sample of pupils in Fourth class in primary schools.
2. Compare the performance of pupils in 2004 against the benchmarks established in the 1999 National Assessment of Mathematics Achievement in Fourth class.
3. Examine the use of calculators by pupils in Fourth class
4. Examine associations between relevant pupil, teacher and school factors and mathematics achievement, and report on any changes arising since the 1999 national assessment.
5. Examine ways in which the teaching and assessment of mathematics have evolved since the introduction of the new Primary Schools Mathematics Curriculum
6. Obtain the views of members of the inspectorate (primary level) on the teaching and assessment of mathematics in schools
7. Make recommendations with regard to the teaching and assessment of mathematics in schools.

## **What is the Framework for the 2004 Assessment?**

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The 1999 National Assessment of Mathematical Achievement employed a framework based on the 1999 Primary Schools Mathematics Curriculum (DES/NCCA, 1999). Although the curriculum had not been implemented in schools at the time (it was introduced to schools in the September following the assessment), it was felt that the new test should, where possible, adhere to the 1999 curriculum framework. The framework took into account both content and mathematical processes. Table 1 shows a breakdown of the 1999 assessment by mathematical content area. Of the 125 on the test, 37% were drawn from the Number area (i.e., place value, operations with numbers, fractions and decimals). Thirty-five percent of items were drawn from the Measures area (length, weight, capacity, area, time and money), 14% from Shape/Space (2- and 3-dimension shapes), 9% from Data/Chance, and just 5% from Algebra.

*Table 1: Distribution of Items by Mathematics Content Area – 1999 National Assessment of Mathematics Achievement*

<b>Content Area</b>	<b>No. of Items</b>	<b>Percent of Items</b>
Number	46	36.8
Algebra	6	4.8
Shape/Space	18	14.4
Measures	44	35.2
Data/Chance	11	8.8
Total	125	100.0

The 125 items administered in the assessment were also categorised by mathematical process. Table 2 gives the percentages of items in each of 6 Processes.

*Table 2: Distribution of Items by Mathematics Process – 1999 National Assessment of Mathematics Achievement*

<b>Process</b>	<b>No. of Items</b>	<b>Percent of Items</b>
Understanding and Recall	17	13.6
Using Strategies/ Implementing Procedures	37	29.6
Reasoning	27	21.6
Integrating and Connecting	8	6.4
Analysing and Solving Problems, and Evaluating Solutions	36	28.8
<b>Total</b>	<b>125</b>	<b>100.0</b>

The 2004 test will be based on the same framework that was used in 1999. It is proposed to retain 114 of the 125 items used in 1999. Eleven additional items (piloted in schools in February 2004) are to be added to the test, in place of 11 of the 1999 items. The new items are in the following areas:

- *Place Value* – exploring and identifying place value in decimal numbers to two places of decimals.
- *Properties of Multiplication* – the zero, commutative and distributive properties.
- *Fractions* – expressing one number as a fraction of another number; calculating a number given a fraction of the number.
- *2-D Shapes* – solving problems involving 2-D shapes.
- *3-D Shapes* – recognition of additional 3-D shapes.
- *Lines and Angles* – identification various lines and angles.
- *Measures (Capacity and Weight)* – rename units of capacity or weight using decimal or fraction form.
- *Chance* – ordering events in terms of the likelihood of their occurrence.

The inclusion of the new items, in place of existing items, will result in small changes to the framework.

### **What is the Design of the Test?**

In 1999, the 125 test items were distributed over 5 blocks, each consisting of 25 items. Each pupil was asked to complete three blocks, or 75 items in total. One of the five blocks (designated a ‘common’ block) was completed by all pupils, while the remaining blocks were assigned at random to pupils.

In 2004, it is planned to add one additional block, called the ‘calculator’ block. This block, which was also piloted in schools in February 2004, consists of items for which use of a calculator is expected to be beneficial. The addition of this block reflects the increased use of calculators by pupils from Fourth class upwards, in line with the 1999 Primary Schools Mathematics Curriculum. Table 3 shows the design of the test, based on the implementation of an additional block: Each pupil will be asked to complete one booklet.

*Table 3: Order of Blocks within Booklets – 2004 National Assessment of Mathematics Achievement*

<b>Booklet</b>	<b>Blocks</b>
1	Block A, Common Block, Block B
2	Block B, Common Block, Block C
3	Block C, Common Block, Block D
4	Block D, Common Block, Calculator Block
5	Calculator Block, Common Block, Block A

### **What Mathematics Skills Does NAMA 2004 assess?**

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Test items follow either multiple-choice or short-answer format. The following are examples of the types of items that pupils taking the 2004 National Assessment of Mathematics Achievement will be expected to attempt:

#### **Number:**

- Divide a two-digit number by a single-digit number (e.g.,  $56 \div 8$ )
- Subtract a three-digit number from a four-digit number (e.g.,  $2273 - 294$ )
- Identify the fraction represented by the shaded area of a 2-D shape
- Estimate the answer to a one-step problem involving repeated addition
- Identify a decimal number between two given numbers (e.g., 11 and  $11\frac{1}{2}$ )
- Round a four-digit number to the nearest 100

#### **Measures:**

- Identify the longest distance among four given distances
- Measure the length of an object in cms, using a ruler
- Solve a word problem involving the difference between two quantities of liquid
- Compute the perimeter of a 2-D shape
- Identify the shortest distance between two towns on a map

#### **Algebra:**

- Identify the next three numbers in a sequence of natural numbers
- Identify the number sentence corresponding to a word problem

#### **Data/Chance:**

- Complete a bar-line graph, based on the information provided
- Identify the everyday event among four that is most likely to happen
- Identify the number of different routes that can be taken between two towns on a map

#### **Shape and Space:**

- Identify essential properties of a triangle
- Identify the number of faces on a 3-D shape
- Identify the number of curved and straight faces on a 3-D shape.

## **How were schools and pupils selected?**

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In January, 2004, a sample of 152 schools was selected to participate in the National Assessment of English (NAER04) and the National Assessment of Mathematics Achievement (NAMA04). The sample includes 138 schools with pupils in fourth class. Schools were selected using the Department of Education and Science's 2002/03 school's database, which includes the names of primary schools and the numbers of male and female pupils enrolled at the different class levels.

Prior to sampling schools, all schools on the database were categorised according to whether they are large (defined as 35 or more pupils in Fifth class), medium (21-34 pupils) or small (fewer than 21 pupils). Schools were also classified according to whether they had pupils in the first, fourth and fifth classes, or whether they had pupils in the fourth and fifth classes, but not in first class. Hence, six strata were established: large, medium and small schools with first, fourth and fifth classes; and large, medium and small schools with fourth and fifth classes, but not first. Within these strata, schools were sorted by designated disadvantaged status, area/language of instruction (Gaeltacht, Scoil lán-Ghaeilge, Ordinary School), proportion of female pupils, and measure of size. This was done to ensure a representative mix of school types.

Several considerations were taken into account in deciding on the number of schools to be selected, including the following:

- *Clustering between schools* – an estimate of the extent of the differences in mathematics achievement between schools (called rho) was obtained using data from earlier national assessments of mathematics.
- *Cluster size* – an estimate of the average number of pupils likely to be enrolled in Fourth class in each stratum was computed using data from earlier studies.
- *Probable response rate within schools* – an estimate was obtained from the 1999 National Assessment of Mathematics Achievement.
- *Required number of responses per test item* – scaling requirements dictated that approximately 1000 responses per test item would be required.
- *The need to achieve an effective sample size of at least 400 pupils* – this means that the sample should provide the same information as a sample 400 pupils in fourth class selected at random across all primary schools.

Taking these issues into consideration, 136 schools were selected. Table 4 gives a breakdown of the schools by stratum.

*Table 4: Numbers of schools selected by stratum and estimated effective sample size – National Assessment of Mathematics Achievement, 2004*

<b>Stratum</b>	<b>Schools</b>	<b>Estimated Cluster Size</b>	<b>Pupils</b>	<b>Estimated Rho</b>	<b>Effective Sample</b>
4th & 5th only - Large	16	50	800	0.21	71
4th & 5th only - Medium	10	25	250	0.21	41
4th & 5th only - Small	10	10	100	0.21	35
1st, 4th & 5th - Large	52	50	2600	0.21	230
1st, 4th & 5th - Medium	24	25	600	0.21	99
1st, 4th & 5th - Small	24	10	240	0.21	83
<b>Total</b>	<b>136</b>		<b>4590</b>		<b>560</b>

The second stage of sampling involves the selection of pupils within participating schools. All pupils in Fourth class in schools with two or fewer Fourth classes will be invited to participate. Where there are more than two fourth classes, the Educational Research Centre will select two Fourth classes at random, and will inform schools ahead of the assessment which classes have been selected. All pupils in selected classes are expected to participate in the assessment except pupils whose teachers deem them to be unable to attempt the mathematics test because, including:

- pupils in ordinary classes assessed as having a moderate to severe general learning disability
- pupils with a physical disability that would prevent them from participating without special accommodation (e.g., a pupil with poor eyesight)
- non-national pupils whose proficiency in English/Gaeilge is at such a level that, in the opinion of the class teacher or principal, they could not attempt the test.

The inclusion of pupils with diagnosed mild general learning disabilities, and pupils who are in receipt of learning support for mathematics is necessary to obtain information on the performance of these pupils, and to ensure comparability with the 1999 National Assessment of Mathematics Achievement.

Principal teachers of Gaeltacht schools and Scoileanna lán Ghaeilge will be asked to indicate whether they wish pupils in their school to attempt the assessment in English or in Irish.

## What are the Contents of the Questionnaires?

Background questionnaires will be administered to generate contextual information with which to interpret the achievement outcomes of the 2004 National Assessment of Mathematical Achievement. The questionnaires, which are summarised in Table 5, and described in greater detail below, are broadly similar to those used in the 1999 survey.

*Table 5. Questionnaires to administered as part of the 2004 National Assessment of Mathematical Achievement*

<b>Measure</b>	<b>To be Completed by. . .</b>
School Questionnaire	Principal Teachers
Teacher Questionnaire	Class Teachers
Learning-Support Questionnaire	Learning-Support Teachers
Parent Questionnaire	Parents/Guardians
Pupil Questionnaire	Pupils
Pupil Rating Form	Class Teachers
Questionnaire for Inspectors	Inspectors

### ***The School Questionnaire***

This questionnaire addresses school-level issues concerning the teaching and learning of mathematics and focuses on the following:

- General information – such as the type of community served by the school, the number of pupils in ordinary classes, and the number of pupils in 4th Class;
- Provision of Learning Support – the number pupils currently in receipt or in need of Learning Support or Resource Teaching in mathematics;
- School resources – the identification of ‘significant problems’ that impede the teaching and learning of mathematics;
- School organisation – planning for the teaching and learning of mathematics, and information regarding school policy on the teaching and assessment of mathematics;
- Revised Curriculum – the implementation of the *1999 Primary School Mathematics Curriculum* and changes in pupil achievement as a result.

### ***The Teacher Questionnaire***

This questionnaire addresses issues related to the teaching and learning of mathematics and focuses on the following:

- Background of teachers – previous teaching experience and qualifications;
- Planning for the teaching of mathematics – use made of curriculum documents, textbooks and other materials;
- Use of resources (textbooks, workbooks, computer software, etc.) to teach mathematics;
- Satisfaction with in-career development on the *1999 Primary School Mathematics Curriculum*;
- Classroom Organisation – teaching multigrade classes; and grouping pupils for mathematics;
- Assessment Practices – the frequency with which homework is assigned, and the use of standardised tests.

### ***The Learning-Support Teacher Questionnaire***

This questionnaire addresses issues related to the provision of Learning-Support teaching in mathematics and focuses on the following:

- Background of teachers – previous teaching experience, number of schools in which they provide Learning Support in mathematics, number of pupils/groups taught;
- Allocation of time to various activities e.g., teaching pupils, contact time with teachers, communicating with parents;
- Information regarding the school's policies on and organisation of Learning Support, and the level of involvement of Learning-Support teacher;
- Satisfaction with in-career development on the provision of Learning-Support teaching for mathematics;
- Grouping of pupils for mathematics, and the level of emphasis given to various aspects of the curriculum;
- Assessment practices – the use of standardised tests, and criteria for identifying and selecting pupils for Learning-Support teaching.

### ***The Parent Questionnaire***

The Parent Questionnaire addresses home factors that might be related to achievement in mathematics and focuses on the following:

- Amount of time that the child spends doing homework, and the amount of help the child receives from parents and others;
- Home-School links – frequency of parent contact with the school to discuss the child's progress in mathematics, involvement in parenting programmes to help with mathematics in the home;
- Involvement with the child in a range of everyday mathematical activities – e.g., estimating the cost of items;
- Satisfaction with child's progress in different aspects of mathematics;
- Family background – the parent's own education and employment status, numbers of siblings, languages spoken in the home.

### ***The Pupil Questionnaire***

The Pupil Questionnaire seeks information about each pupil's level of involvement in learning mathematics, and their interest in the subject and focuses on the following:

- Involvement in a range of academic, social and leisure activities – including amount of time allocated to homework in mathematics and in other subjects;
- Engagement in various activities related to homework in mathematics – including frequency of requests for help from parents and others, and use of calculators, computers and table books;
- Involvement in various activities related to schoolwork in mathematics – including frequency with which help was sought from teacher and other pupils;
- Attitudes towards mathematics and confidence when engaging in mathematical tasks.

### **Pupil Rating Form**

The Pupil Rating Form collects information about the characteristics of each pupil who participated on a range of variables:

- Engagement in school work – participation and attention in class, school attendance, general aptitude for learning and general academic achievement;
- The pupil's achievement in mathematics – including the pupil's proficiency in mathematics, and the class level corresponding to the pupil's current ability level in mathematics;
- Learning Support/Resource Teaching in mathematics – including whether the pupil is currently receiving support, or has received such support in the past, and whether the pupil has ever been diagnosed as having a learning disability in mathematics.

### **Questionnaire for Inspectors**

This questionnaire covers a range of issues relating to the teaching and assessment of mathematics in schools and classrooms, including:

- The usefulness of various approaches to the organisation of mathematics teaching in schools;
- Satisfaction with the teaching of mathematics in 4<sup>th</sup> Class and the achievement of pupils in 4<sup>th</sup> Class;
- Satisfaction with the school development plan on the teaching and learning of mathematics;
- Satisfaction with the preservice training and in-career development of teachers – including the identification of specific skills on which additional in-career development is needed by teachers;
- Factors that contribute to differences in the mathematical achievement of pupils.

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## Who are the NAMA 2004 National Committee Members?

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Name		Organisation
Seán	Ó Cearbhaill	Department of Education and Science, Chair
Pádraic	Bearnais	Department of Education and Science
Bairbre	Boylan	National Council for Curriculum and Assessment
Shirley	Brook	Church of Ireland Board of Education
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