



Research summary – A brief review of calculator usage in mathematics

Rebecca Grayson

February 2013

**Research Division
Assessment Research and Development
Cambridge Assessment
1 Regent Street, Cambridge, CB2 1GG**

Contents

1	Method	3
2	Calculators in GCSE and IGCSE / Certificate Mathematics qualifications in England.....	4
2.1	Balance of calculator usage in GCSE and IGCSE / Certificate Mathematics	4
2.2	Topics assessed using non-calculator papers (GCSE Mathematics only)	4
2.3	Types of calculator that are permitted.....	4
3	Calculators in the teaching of mathematics in England and other jurisdictions.....	5
3.1	Ages at which different types of calculator are introduced into teaching in England	5
3.2	Age at which calculators are used in teaching in different jurisdictions	5

1 Method

A brief literature review indicated that whilst there was substantial literature on the use of calculators in mathematics lessons, little work had been done on the use of calculators in assessment. Internet searches were carried out to identify current policies on calculator use in mathematics qualifications in England. Data from the Trends in International Mathematics and Science Study (TIMSS) studies in 2003 and 2007 were used to investigate the use of calculators in other jurisdictions.

2 Calculators in GCSE and IGCSE / Certificate Mathematics qualifications in England

2.1 Balance of calculator usage in GCSE and IGCSE / Certificate Mathematics

All GCSE and IGCSE / Certificate Mathematics specifications permit calculators in at least part of the qualification assessment; however, the extent of calculator usage varies considerably. The total weighting of assessment in which calculators are permitted ranges from a minimum of 50% to a maximum of 100%. Variability in calculator usage across the specifications relates directly to the subject criteria or framework documents for these qualifications. The qualifications without restrictions on calculator usage (GCSE Methods in Mathematics and IGCSE / Certificate Mathematics) have 100% calculator assessment.

2.2 Topics assessed using non-calculator papers (GCSE Mathematics only)

The knowledge, understanding and skills required in all GCSE Mathematics specifications accredited for English candidates are set out in the Ofqual GCSE subject criteria for mathematics. It is left to the individual awarding bodies to determine how the content is allocated to calculator and non-calculator assessment. The specifications for linear GCSE Mathematics do not stipulate which content will be assessed via the calculator and non-calculator papers. However, the September 2012 specifications for 'ex-modular' GCSE Mathematics specify the content allocated to the non-calculator and calculator units.

2.3 Types of calculator that are permitted

The Joint Council for Qualifications instructions for conducting examinations for general and vocational qualifications in England contains detailed rules on the types of calculator that are permitted in calculator examinations. Computer Algebra System (CAS) calculators with algebraic functions are prohibited; however, both scientific and graphical calculators are acceptable. All of the GCSE and IGCSE / Certificate Mathematics specifications permit the use of both scientific and graphical calculators except CIE IGCSE Mathematics 9580, which prohibits the use of graphical calculators.

Each of the mathematics specifications has a minimum calculator requirement. For GCSE qualifications the minimum requirement is a scientific calculator with statistical and trigonometric capacity. The CIE IGCSE Mathematics specification only requires a calculator with the capacity to report to three significant figures.

3 Calculators in the teaching of mathematics in England and other jurisdictions

3.1 Ages at which different types of calculator are introduced into teaching in England

Basic calculators (not scientific or graphical) are first introduced into teaching in England during Key Stage 2, between ages 7 and 11, for use where appropriate. Key Stage 3 and 4 pupils are also required to use calculators as appropriate. The Key Stage 3 and 4 programmes of study do not specify what type of calculators should be used; however, at the most advanced level the programmes do require that pupils have familiarity with graphical calculators.

3.2 Age at which calculators are used in teaching in different jurisdictions

In 2007 the Trends in International Mathematics and Science Study (TIMSS) explored three different aspects of calculator use: (i) whether or not the National Curriculum contains policies or statements about the use of calculators; (ii) the percentage of students not permitted to use calculators in mathematics classes; and (iii) the percentage of students using calculators for various activities in about half of the lessons or more. (Unfortunately none of these issues were investigated in the more recent TIMSS 2011.)

Data on calculator use was available for 36 of the 59 TIMSS 2007 countries at Grade 4. Just under half of these countries (47.2%, N = 17) had policies or statements about the use of calculators within the Grade 4 National Curriculum and almost two thirds (64.6%, N = 31) had policies or statements about the use of calculators within the Grade 8 National Curriculum. On average 54% of teachers across the countries reported that calculators were not permitted. England was the most permissive country; only 2% of teachers reported that calculators were not permitted. Singapore, Kuwait, Ukraine, Slovenia, Hungary, Austria, Tunisia and Latvia were the least permissive countries; more than 90% of teachers reported that calculators were not permitted. Calculators were most commonly used in lessons which involved solving complex problems or checking answers, and were least commonly used in lessons which involved routine calculations.

Calculator usage data was available for 48 of the 59 TIMSS 2007 countries. Of these countries, almost two thirds (64.6%, N = 31) had policies or statements about the use of calculators within the Grade 8 National Curriculum. In the Grade 8 classroom an average of 25% of teachers across the countries reported that calculators were not permitted. England was among the most permissive countries; only 1% of teachers reported that calculators were banned. In several other countries, including Malaysia, Singapore, Hong Kong and Scotland, fewer than 2% of teachers reported that calculators were banned. Notably, England and Scotland were among the most permissive countries at both Grade 4 and Grade 8. Calculators were most commonly used in lessons which involved solving complex problems, doing routine calculations and checking answers, and were least commonly used in lessons which involved the exploration of number concepts.

Calculator use was also investigated in the TIMSS 2003 study. Between the 2003 and the 2007 studies five countries displayed a significant increase in the usage of calculators in the Grade 4 classroom: Armenia, Hong Kong, Latvia, Lithuania and the Russian Federation. New Zealand was the only country to display a significant decrease in calculator use at this level. At Grade 8, three countries displayed a significant increase in the usage of calculators in the classroom: Jordan, Malaysia and Slovenia. In contrast, four countries displayed a significant decrease in the usage of calculators at this level: Bahrain, Ghana, Serbia and the United States.