Nuffield Foundation

An international comparison of upper secondary mathematics education

24 Country Profiles

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This information in these country profiles is the evidence base for the report: *Is the UK an Outlier? An international comparison of upper secondary mathematics education.*

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Foreword

It is often said that the British education system is unusual in requiring or enabling so few of its young people to continue studying mathematics after the age of 16. If true this seems a matter of some significance, but looking into the matter we could find little systematic evidence either way. We therefore commissioned a study to gather evidence on the real position, both to support our own work and to inform the national debate about future directions for mathematics education.

The research was carried out by Dr Jeremy Hodgen and David Pepper from King's College London; and Linda Sturman and Graham Ruddock from NFER. They have done an excellent job in tackling what turned out to be a complex question and we are grateful to them. The research addresses a number of questions about policy and participation in upper secondary mathematics education in 24 countries (mainly from the OECD), including the four countries of the UK.

We have published a report summarising the findings entitled: *Is the UK an Outlier? An international comparison of upper secondary mathematics education.* Underpinning the summary report is a country profile for each of the 24 countries surveyed, and these are published here in full.

The findings are stark. In England, Wales and Northern Ireland fewer than one in five students study any mathematics after the age of 16 (Scotland does slightly better). In 18 of the 24 countries more than half of students in the age group study mathematics; in 14 of these, the participation rate is over 80%; and in eight of these every student studies mathematics. When it comes to the mathematics education of its upper secondary students the UK is out on a limb.

Moreover the situation is not static. Few of these other countries are satisfied with levels of achievement and participation in post-16 mathematics, and most are devising policies and reforms aimed at increasing these levels.

Many questions arise from this research. Do these levels of participation and achievement meet the needs of the workforce? Do they adequately prepare young people for further and higher education? If not should A-level mathematics continue to provide the sole route for expansion or are alternative routes needed? And – given the critical role that primary schools play in providing all young people with the foundations for mathematical learning – is it acceptable that the majority of primary teachers do not study mathematics beyond GCSE?

We urge those involved with mathematics education, whether in policy or practice, to consider the new evidence provided in this report and its implications for post-16 mathematics education in the UK.

Anthony Tomei
Director, Nuffield Foundation

Introduction

This compilation of country profiles is published alongside our report, *Is the UK an Outlier? An international comparison of upper secondary mathematics education.* The report provides a comparative analysis of upper secondary mathematics education in 24 countries, including England, Scotland, Wales and Northern Ireland.

The report is based on data collected as part of a research review, which was subsequently validated and supplemented by national contacts and other country experts in each of the surveyed countries. We are extremely grateful for their support, and a full list can be found in Appendix A.

The information is presented here in the form of 24 country profiles, each of which addresses the following questions:

Main research questions

1. What is the national policy for, and structure of, mathematics education provision for 16-18/19 year-old (pre-university level) learners?

2. What are the overall participation rates in mathematics study for 16-18 year-olds both as proportions of students and proportions of the age cohort?

3. What are the patterns of participation in terms of following different routes involving mathematics?

4. What is the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

Additional research questions

5. What drives the pattern of take-up? How is it linked to the needs of higher education, employers and national policy objectives?

6. How is the picture changing over time?

Countries surveyed

Our survey includes a total of 24 countries, including the four UK countries. Sixteen of these (including the UK), are economically developed members of the Organisation for Economic Co-operation and Development (OECD), two are OECD accession countries and three are non-OECD countries from the Pacific Rim. We chose the three Pacific Rim countries because of their high performance in international surveys of attainment in mathematics (PISA and TIMSS).

For the three countries in which education policy is decided by sub-national jurisdictions, we focussed on New South Wales in Australia, British Columbia in Canada and Massachusetts in the USA. The focus on these single jurisdictions reflects the limited time available for the investigation. It also reflects our judgment that they are of particular interest in the UK context and that the necessary information was accessible. The full list of countries surveyed is as follows:

UK NATIONS	OECD COUNTRIES	OECD ACCESSION COUNTRIES	NON-OECD / PACIFIC RIM / HIGH ATTAINING
England Northern Ireland Scotland Wales	Australia (New South Wales) Canada (British Columbia) Czech Republic Finland France Germany Hungary Ireland Japan Korea Netherlands New Zealand Spain Sweden USA (Massachusetts)	Estonia Russian Federation	Hong Kong Singapore Taiwan

Methodology

The methodology responds to the apparent lack of comparative international literature on upper secondary mathematics education and, more specifically, the research questions set out above. The work was carried out between April and July 2010 in four stages.

Stage 1: Online searches

We began with a systematic online search including the INCA website (www.inca.org.uk), Eurydice website (www.eurydice.org) and the TIMSS 2006 Encyclopaedia. We also included Ministry of Education websites or those of the arms-length technical bodies (Boyle, 2008) responsible for curriculum and qualifications arrangements in each of the target countries.

We used a mixture of English-language sources, including international databases, policy literature, national data and curricula or syllabi documents. We wrote up results in the form of draft country profiles that addressed each of the six research questions.

Stage 2: International enquiries

For each of the countries, we asked a national contact from our international networks to review the relevant draft country profiles collected in Stage 1. Their role was to validate this information and to provide any important supplementary detail they could offer.

Stage 3: Final short descriptions for each country and a detailed annex

We developed the information gathered in Stages 1 and 2 into final country profiles, including full references. The 24 country profiles are available to download from **www.nuffieldfoundation.org.**

Stage 4: Overall summary and comparative analysis

In this final stage of the investigation we identified similarities and differences across the countries, particularly in comparison with the education systems in the four UK countries.

Caveats and limitations

Any international comparison comes with a caveat – different countries collect data in different ways, for different purposes. In addition, terms such as 'vocational' can have different meanings in different countries.

We are confident that in broad terms our findings represent a reliable and valid comparison of upper secondary mathematics in the UK and internationally. Nevertheless, there is a strong note of caution to the figures in this report. The statistics produced by each country are not absolutely comparable. They are produced on different bases and often over different time periods. Rarely are margins of error noted in the statistical sources. It is also important to note that few other countries have the level and detail of statistics available as are available in the UK (Schnepf & Micklewright, 2006).

We have often calculated proportions of proportions thus increasing the margin of error. When making quantitative comparisons between countries (as in Tables 5 and 6), we have made judgements based on interval estimates rather than point estimates. We have indicated how these judgements have been reached in the notes to the tables.

Abbreviations

ISCED: International Standard Classification of Education

FSMQ: Free-Standing Mathematics Qualification

GCE: General Certificate of Education

GCSE: General Certificate of Secondary Education

HAVO: Hoger Algemeen Voortgezet Onderwijs
(Netherlands, Senior Secondary Education)

NCEA: National Certificate of Educational Achievement (New Zealand, Upper Secondary)

VWO: Voorbereidend Wetenschappelijk Onderwijs (Netherlands, Pre-university education)

Terminology

Upper secondary education: This term includes all forms of education for this age group, including school, college and employment-based options, but excluding tertiary education. In the UK, upper secondary education is commonly referred to as "post-16", but we chose not use this term for reasons of comparability between countries. For example, in several countries upper secondary begins at a younger age than 16. Furthermore, many countries require students to repeat a grade, meaning that unlike the UK, not all post-16 students are in upper secondary education.

General education: Indicates pre-university or, more broadly, pre-tertiary education as delivered by schools and colleges.

Vocational education: Vocational education and training (VET) within upper secondary education. This covers education programmes and pathways explicitly linked to particular employment sectors or occupations. In many countries, upper secondary vocational education and training is provided partially or wholly by schools and colleges, as a function of the balance between theoretical and practical learning.

Advanced mathematics: Studying mathematics at some level equivalent to GCE Mathematics. In practice, this consists of ISCED Level 3 study with a minimum content level of the pure modules of GCE AS Mathematics in England.

Basic mathematics: Anything less than advanced mathematics and may consist of anything above ISCED Level 1 equivalent. In curriculum terms, this is usually described as equivalent to GCSE Mathematics in England or a little beyond, but with what is often described in terms of "use of mathematics", "modelling" or "applications" that may involve a small amount of ISCED Level 3 study.

Further mathematics: Extended study in advanced mathematics equivalent to at least the pure elements of GCE A2 mathematics and AS Further Mathematics in England.

Australia (New South Wales)

1. What is the national policy for, and structure of, mathematics education provision for 16-18/19 year-old (pre-university level) learners?

In New South Wales (NSW) it is compulsory for students to remain at school until they finish Year 10 (ages 15-16). Unless moving into full time work, students then have to continue to participate in school education or further training until they have turned 17.

Secondary education is generally provided in secondary schools. However there are some primary/secondary schools that cater for the complete age range (5 to 17+).

Parents have freedom of choice to send their child to any government school; however, priority is given to children living locally. Therefore other children may only be accepted if there are sufficient extra spaces. Government schools are free. Non-government, or private, schools charge tuition fees but also get some government funding.

All NSW students must study mathematics each year from kindergarten through to Year 10. In years 7-10 students study towards the School Certificate. To gain this, students must have, inter alia, completed 400 hours of mathematics (minimum 100 hours per year). They must also satisfactorily undertake five School Certificate tests, including mathematics, at the end of Year 10.

In Years 11 and 12 school students study towards the Higher School Certificate. Vocational subjects can be studied by school students as part of the Higher School Certificate. These students have the option of selecting from the same mathematics courses as other HSC students.

The only compulsory subject for the Higher School Certificate is English, with mathematics being the most popular elective subject.

QUALIFICATION	MATHEMATICS COURSES
Higher School Certificate (HSC) – the senior secondary school qualification in NSW	*Mathematics Life Skills* (for students with special education needs) *General Mathematics* *Mathematics* *Mathematics Extension 1* *Mathematics Extension 2*
Further education and training qualifications studied outside of the school system	Students who choose to leave school at the end of Year 10 to undertake further education and training in a TAFE (Technical and Further Education) college or a private college may need to study additional mathematics if required for their vocational learning. Mathematics courses offered by further education providers may be in the form of general bridging courses and/or may be vocationally-specific topics.

2. What are the overall participation rates in mathematics study for 16-18 year-olds both as proportions of students and proportions of the age cohort?

The tables below show the percentages of all HSC-eligible students in a given year who studied each of the HSC mathematics courses in that year. (Note that these figures do not represent the whole 16-18 year old cohort because some HSC students are not 16-18 years old, and some in this age bracket are in technical and further education rather than undertaking the HSC.)[1]

Figures are provided from 2001, which was the first year in which the current courses were examined for the Higher School Certificate. A description of each of the HSC mathematics courses is provided in Section 4 of this document.

Students whose highest level mathematics course is *Mathematics Extension 1* sit both the *Extension 1* examination and the *Mathematics* examination. Students who study *Mathematics Extension 2* sit both the *Extension 2* examination, as well as the *Extension 1* examination. For each HSC mathematics course, the table shows the number of students who have studied at that level *at most*. Students who have completed the *Extension 1* or *Extension 2* courses have been excluded from the *Mathematics* and *Extension 1* counts, respectively.

HIGHEST LEVEL OF HSC MATHEMATICS STUDIED GIVEN YEAR						
CALENDAR YEAR (%)	MATHEMATICS LIFE SIKILLS (%)	GENERAL MATHEMATICS (%)	MATHEMATICS (%)	MATHEMATICS EXTENSION 1 (%)	MATHEMATICS EXTENSION 2 (%)	ANY MATHEMATICS (%)
2009	1.7	47.1	18.5	8.6	5.0	80.8
2008	1.7	47.5	18.7	8.6	4.9	81.4
2007	1.8	47.3	19.5	9.0	4.8	82.4
2006	1.6	47.6	19.9	9.6	5.1	83.8
2005	1.7	46.9	21.1	10.0	5.3	85.1
2004	1.6	47.7	21.6	10.5	5.7	87.0
2003	1.6	49.2	22.7	10.0	5.3	88.8
2002	1.5	51.7	23.1	10.3	4.9	91.5
2001	1.3	50.4	25.0	10.7	4.4	91.8

1 In 2008, an estimated 67% of the age cohort eligible to complete HSC actually did so: https://www.det.nsw.edu.au/media/downloads/reports_stats/stats/completion.pdf

3. What are the patterns of participation in terms of following different routes involving mathematics?

See section 2 above.

4. What is the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

The *General Mathematics* course is a non-calculus course with a practical emphasis. The content includes financial mathematics, data analysis, measurement, probability and algebraic modelling. The *Mathematics* course is a calculus-based course, as are the *Extension* courses, which build upon this course. A more detailed description of each course follows[2].

General Mathematics (approx 240 hours)

This course focuses on mathematical skills and techniques which have direct application to everyday activity. The course content is written in five areas of study, with an emphasis on application of specific skills and on tasks that involve integrating mathematical skills and techniques across a range of familiar and unfamiliar situations. These tasks may draw from more than one area of study, and encourage transfer of knowledge across the entire course, as well as linking with study in other subjects. The course is fully prescribed, and is designed to support TAFE and other vocational courses. It provides an appropriate mathematical background for students who do not wish to pursue the formal study of mathematics at tertiary level, while giving a strong foundation for university study in the areas of business, humanities, nursing and paramedical sciences.

Mathematics (approx 240 hours)

This course is intended to give students who have demonstrated general competence in mathematics an understanding of and competence in some further aspects of mathematics which are applicable to the real world. It has general educational merit and is also useful for concurrent studies in science and commerce. The course is a sufficient basis for further studies in mathematics as a minor discipline at tertiary level in support of courses such as the life sciences or commerce. Students who require substantial mathematics at a tertiary level, supporting the physical sciences, computer science or engineering, are advised to undertake the *Mathematics Extension 1* course or both the *Mathematics Extension 1* and *Mathematics Extension 2* courses.

Mathematics Extension 1 (approx 120 hours)

This course is intended to give able mathematics students a thorough understanding of and competence in aspects of mathematics, including many which are applicable to the real world. It has general educational merit and is also useful for concurrent studies of science, industrial arts and commerce. The course is a recommended minimum basis for further studies in mathematics

2 Syllabi available from: http://www.boardofstudies.nsw.edu.au/syllabus_hsc/

as a major discipline at a tertiary level and for the study of mathematics in support of the physical and engineering sciences. Although the course is sufficient for these purposes, students of outstanding mathematical ability are advised to consider undertaking the *Mathematics Extension 2* course.

Mathematics Extension 2 (approx 60 hours)

This course is designed for students with a special interest in mathematics who have shown that they possess special aptitude for the subject. The course offers a suitable preparation for study of mathematics at tertiary level, as well as a deeper and more extensive treatment of certain topics than is offered in other mathematics courses. It represents a distinctly high level in school mathematics involving the development of considerable manipulative skill and a high degree of understanding of the fundamental ideas of algebra and calculus. These topics are treated in some depth.

All HSC mathematics courses (other than *Life Skills*) can be counted towards university entry. Universities may require students to have undertaken one of the calculus-based courses as assumed knowledge for particular degrees.

5. What drives the pattern of take-up? How is it linked to the needs of HE, employers and national policy objectives?

There is a complex range of factors involved in students' course choices. The mandatory *School Certificate Mathematics* course is designed to provide students with the essential mathematical knowledge and skills needed for everyday life beyond school.

If students want to go on to higher education they need to achieve their HSC. If students do not continue with mathematics in their final years of schooling this may impact on their tertiary options and career opportunities. There is a nationwide shortage of specialist mathematics teachers which has an impact on take-up and not all schools teach the most advanced mathematics course. Some universities are lowering the mathematics requirements they ask of students for particular degrees.[3]

6. How is the picture changing over time?

As can be seen from the table in section 2 above, the take-up of senior secondary mathematics courses in New South Wales has reduced between 2001 and 2009.[4]

3 http://www.aare.edu.au/07pap/chi07180.pdf

4 http://www.aare.edu.au/07pap/chi07180.pdf

Canada (British Columbia)

1. What is the national policy for, and structure of, mathematics education provision from 16-18/19 year old (pre-university level) learners?

Canada:

Grade/Year 11 (upper secondary) corresponds to age 16/17 or 17/18
Grade/Year 12 (upper secondary) corresponds to age 17/18 or 18/19

Mathematics is compulsory up to Grade/Year 9 or 10 (ages 14/15+); in some provinces this requirement includes Grade 11.

On completion of upper secondary education, most provinces issue successful students with high school graduation certificates, which are based on course credits and sometimes also on examinations. These are usually prepared and set at local level. The number of compulsory subjects is reduced, permitting students to spend more time on specialised programmes preparing them for the job market, or to take specific courses to help them satisfy the entrance requirements of the college or university of their choice.[1]

British Columbia:

Students entering Grade 10 of high school in British Columbia graduate under the requirements of the 2004 Graduation Program; in which credits from Grades 10, 11 and 12 will count towards graduation.

The three-year high school graduation programme (for 16 to 19 year-olds) involves five examinations: two in language arts, and one each in science, mathematics and social studies, along with the demonstration of competencies by the production of graduation portfolio evidence in various other areas eg art and design.[2]

Courses for the 2004 Graduation Programme are offered in French and English. Three pathways are available: Applications of Mathematics, Essentials of Mathematics and Pre-calculus. Starting in 2010 these courses will be delisted and three new pathways will be implemented: *Apprenticeship and Workplace Mathematics, Foundations of Mathematics, and Pre-calculus*. Implementation will occur over three years as follows: Grade 10 – 2010, Grade 11 – 2011 and Grade 12 – 2012.

A common Grade 10 course called *Foundations of Mathematics and Pre-calculus* will be the starting point for the *Foundations of Mathematics* pathway and the *Pre-calculus* pathway. Each topic area requires that students develop a conceptual knowledge base and skill set that will be useful to whatever pathway they have chosen. The topics covered within a pathway are meant to build upon previous knowledge and to progress from simple to more complex conceptual

1 http://www.inca.org.uk/canada.html

2 http://www.bced.gov.bc.ca

understandings. Students also have options to take BC Calculus 12, International Baccalaureate and Advanced Placement courses in mathematics.

Each course is 4 credits (approximately 100 hours of instruction).[3]

2. What are the overall participation rates in mathematics study for 16 – 18 year olds both as proportions of students and proportions of the age cohort?

2001- 02 school year: 77% of students received the 'Dogwood' certificate (British Columbia's high school graduation certificate). Girls (81%) outnumbered boys (73%) among the graduates. Fewer Aboriginal[4] students (43%) than non-Aboriginal students (80%) gained the certificate.[5]

3. What are the patterns of participation in terms of following different routes involving mathematics?

No data is given since British Columbia is in the midst of a curriculum revision. The data available reflects the current curriculum and will be subject to change under the new curriculum.

4. What is the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

See point 1 for the different modules offered. Curriculum for the different courses can be found online at **www.bced.gov.bc.ca/irp/welcome.php**.

Students are expected to: use communication in order to learn and express their understanding; make connections among mathematical ideas, other concepts in mathematics, everyday experiences and other disciplines; demonstrate fluency with mental mathematics and estimation; develop and apply new mathematical knowledge through problem solving; develop mathematical reasoning; select and use technology as a tool for learning and solving problems; develop visualization skills to assist in processing information, making connections and solving problems.

Design of Pathways (this is for the new courses in the forthcoming curriculum):

Each pathway is designed to provide students with the mathematical understandings, rigour and critical-thinking skills that have been identified for specific post-secondary programs of study and for direct entry into the work force. The content of each pathway has been based on the Western and Northern Canadian Protocol (WNCP) Consultation with Post-Secondary Institutions, Business and Industry Regarding Their Requirements for High School Mathematics: Final Report on Findings and on consultations with mathematics teachers.

3 A credit is a unit of measurement used to give weighting to the value, level, or time requirements of an academic course.

4 First Nations, Métis, and Inuit and Indigenous Peoples

5 http://www2.news.gov.bc.ca/nrm_news_releases/2003BCED0001-000061-Attachment2.htm

Apprenticeship and Workplace Mathematics
This pathway is designed to provide students with the mathematical understandings and critical-thinking skills identified for entry into the majority of trades and for direct entry into the work force. Topics include algebra, geometry, measurement, number, statistics and probability.

Foundations of Mathematics
This pathway is designed to provide students with the mathematical understandings and critical-thinking skills identified for post-secondary studies in programs that do not require the study of theoretical calculus. Topics include financial mathematics, geometry, measurement, number, logical reasoning, relations and functions, statistics and probability.

Pre-calculus
This pathway is designed to provide students with the mathematical understandings and critical-thinking skills identified for entry into post-secondary programs that require the study of theoretical calculus. Topics include algebra and number, measurement, relations and functions, trigonometry, and permutations, combinations and binomial theorem.

5. What drives the pattern of take-up? How is it linked to the needs of HE, employers and national policy objectives?

The upper secondary (senior high school or graduation) years, Grades/Years 10 – 12, in British Columbia focus on preparation for post-secondary studies or entry into the workforce. As courses become increasingly specialised, students continue to expand their knowledge and refine their skills in English, mathematics, science and social studies. They take courses that are directed towards the achievement of their personal and career goals. Students develop advanced skills and take more responsibility for their learning.

Special agreements with Aboriginal people to improve participation rates (in all subjects).

There are many drivers which contribute to the distribution of students these include:

- Post secondary admission requirements
- Student abilities and goals
- Local and global economies
- Course offerings within a school as not all schools can offer all courses
- Availability of distance education options
- Public perception of the courses

6. How is the picture changing over time?

With the upcoming changes in curriculum it appears that post secondary admission criteria may change to align with pre-requisite skills more closely with admission standards. This will shift the focus from the mathematics courses which focus on calculus to other programs. Currently, British Columbia is experiencing a decrease in student numbers.

Czech Republic

1. What is the national policy for, and structure of, mathematics education provision for 16-18/19 year-old (pre-university level) learners?

Education is non-compulsory in the Czech Republic from the age of 15. Students are admitted to upper-secondary education provided they have completed compulsory education. Approximately 93% of students continue to upper secondary education.[1]

Education can be either general or vocational, though vocational education is more common than general education. Students take one of three qualification routes, each differing in length and level.[2]

střední vzdělání s maturitní zkouškou (4 years)

Secondary education completed with *maturitní zkouška* examination - leavers are awarded the *vysvědčení* or *maturitní zkoušce* which allows them to enter a higher level of education. General upper secondary schools prepare students especially for entry to a higher education institution while technical upper secondary schools usually prepare pupils both for an occupation and for their studies at higher education institutions. Technical schools are specialised, e.g. industrial, agricultural, health-related, or commercial.

střední vzdělání s výučním listem (2-3 years)

Secondary education leading to an apprenticeship certificate – this usually prepares pupils for an occupation. Schools are vocationally oriented but give also a broad basis of general education. A holder of an apprenticeship certificate from three-year study courses can enter technical follow-up study (*nástavbové studium*) (ISCED 4A) and sit the *maturitní zkouška* necessary for entry to tertiary education.

střední vzdělání (1-2 years)

Secondary education – this provides limited vocational education.

Approximately 75% of secondary school leavers will hold *střední vzdělání s maturitní zkouškou*, an ISCED level 3A qualification.[3] This can be either technical or general. Fewer than 25% will achieve *střední vzdělání s výučním listem* a primarily vocational qualification at ISCED level 3C. The remainder will leave with *střední vzdělání,* again largely vocational and equating to ISCED level 2C or 3C.[4] Mathematics is a compulsory portion of the curriculum for each of these.

1 http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/national_summary_sheets/047_CZ_EN.pdf

2 http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/eurybase_full_reports/CZ_EN.pdf

3 Day form of study, excluding follow-up study, which is attended solely by 18-year olds and older pupils.

4 For pupils with lesser study prerequisites.

A minority of students will attend *conservatoire*; specialist schools for subjects such as dance or drama. As of the 2009/10 academic year there were only 17 of these schools. At upper secondary education level, mathematics is not included in the *conservatoire* curriculum.

The prerequisite for admission into upper secondary education may include entrance examinations organised by the school. Mathematics is usually part of the entrance examination of schools offering *střední vzdělání s maturitní zkouškou*. The content of the entrance requirements is determined by the school.

2. What are the overall participation rates in mathematics study for 16-18 year-olds both as proportions of students and proportions of the age cohort?

Data is given on the number of pupils in the 15-18 age group which is the age range of upper secondary education in the Czech Republic. Almost 70% of the population complete four years of secondary education. The study in fields for attaining the *střední vzdělání* and *střední vzdělání s výučním listem* is shorter (1-3 years).

DISTRIBUTION OF PUPILS OF *STŘEDNÍ ŠKOLY* AND *CONSERVATOIRES* BY LEVEL OF EDUCATION[5] (DAY EDUCATION ONLY AND INCLUDING SCHOOLS FOR PUPILS WITH SPECIAL EDUCATIONAL NEEDS).

	2008/09	2009/10
Proportion of pupils of *střední školy* (without lower secondary level) to the population cohort 15-18	91.9 %	47.1%
PUPILS OF FIELDS OF:		
- *střední vzdělání s maturitní zkouškou* (general -gymnázium)	20.3 %	20.9%
- *střední vzdělání s maturitní zkouškou* (technical)	48.5 %	50.2%
- *střední vzdělání s výučním listem* (vocational)	22.7 %	23.2%
- *střední vzdělání* (vocational)	0.3 %	0.4%
Proportion of pupils of conservatoires to the population cohort 15-18[6]	0.7 %	0.7 %

3. What are the patterns of participation in terms of following different routes involving mathematics?

In general and technical courses of secondary education, studies are completed with the school-leaving examination (*maturitní zkouška*).

In general courses (*gymnázia*), the school-leaving examination consists of two compulsory subjects (Czech language and literature and a foreign language) and two optional subjects.

5 http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/eurybase_full_reports/CZ_EN.pdf

6 At the level of upper secondary education, mathematics is not included in the conservatoire curriculum.

In technical courses, the students also take the school-leaving examination. In this case it consists of Czech language and literature, one optional subject and vocational subjects appropriate to the course.

Mathematics is not a compulsory subject for the school-leaving examination in principle, but pupils can choose to take it. However, if pupils specialise in mathematics, then mathematics must be one of the examined subjects. National data on the number of students who chose mathematics to be part of the school-leaving examination is not available.

In vocational education, studies are completed with the *závěrečná zkouška* final examination which does not include mathematics.

4. What is the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

Objectives of education, key competencies and educational content are set out in the framework educational programmes (FEPs)[7] of upper secondary schools. Based on the FEP, each school creates its own school educational programmes (SEP).

In the FEP for *gymnázium* (general upper secondary school completed with *maturitní zkouška* examination) in the section "Instruction in Mathematics and its Application" it is stated that mathematics should develop and broaden the understanding of quantitative and spatial relationships in the real world and improve the pupil's quantitative literacy and ability of geometric insight. Mastery of the required mathematical apparatus, elements of mathematical thinking, creation of hypotheses and deductive speculations are all means of providing a new, deeper understanding and are requisites for further study.[8]

Besides having a general educational aspect, mathematical education in vocational courses (*střední odborné vzdělávání*) comprises a further preparatory function for the vocational part of education (mathematics education in the Framework Education Programmes (FEPs) for vocational courses of *střední vzdělání s maturitní zkouškou* and FEPs for *střední vzdělání s výučním listem*).

For courses with increased mathematical demands, the schools extend mathematical education in their programmes.

Mathematical competencies are among the eight key competencies in FEPs for vocational courses leading to *maturitní zkouška* examination and FEPs for courses leading to apprenticeship certificates.

7 The FEPs for upper secondary technical and vocational education are prepared simultaneously with the new National Qualification Framework which defines some 270 fields of education instead of former 800. Programmes are being approved in four phases (2007, 2008, 2009 and 2010). In two years following the approval, schools must prepare their own school educational programmes and start teaching on their basis.

8 For the full content of mathematical education at gymnázia see the English translation of FEP http://www.vuppraha.cz/wp-content/uploads/2009/12/RVP_G-anj.pdf

5. What drives the pattern of take-up? How is it linked to the needs of HE, employers and national policy objectives?

Higher educational institutions (ISCED 5A) and tertiary professional schools (ISCED 5B) have no requirements concerning the choice of subject at the *maturitní zkouška* exam. However mathematics is usually part of the entrance exam to higher education programmes aimed at mathematics or related fields.

Requirements for technical and vocational education and the competencies of graduates are based on labour market requirements. Representatives of employers are involved in determining professional profiles and qualification standards.

A three year project of the Ministry of Education, Youth and Sports - *Support for Technology and Science Fields* - started in 2009. The project's main objective is to introduce a system of support for technology and science fields aimed primarily at potential applicants for study at tertiary education institutions. The system of project activities is divided into three main pillars and it is focused on professional support for the teaching and popularisation of science, on publicity and communication, and last but not least on the training of future teachers.

6. How is the picture changing over time?

The 2004 Education Act provided the legislative basis for comprehensive education reform. The reform of education also affects the completion of studies in upper secondary schools.

As a result of the reform of the school-leaving examination, there should be changes in its form (starting from 2011). This new examination will consist of two parts, the common part and the profile part. The common part includes three exams: the Czech language and a chosen foreign language are compulsory. The third can be chosen from mathematics, basics of civic education and social sciences or informatics. The profile part includes two or three compulsory subjects and two or three optional subjects. In the profile part of the exam, the number of compulsory subjects can be influenced by the school head. In addition, the choice of optional subjects in both the common and profile parts can be influenced by the head. Thus the school head can set mathematics as a compulsory subject. For each exam, pupils can choose from two levels of difficulty.

In April 2010, a workshop focused on mathematics education was held at the Ministry of Education, Youth and Sports. Enhanced interest in mathematics education arose from the TIMSS results, which had shown a strong negative trend in the mathematics achievement of fourth graders (primary level) and a slightly negative trend also in the achievement of eighth graders (lower secondary level). The intention of the workshop was to initiate discussion on the possibilities of a systemic change in mathematics, causes of low achievement and possibilities for improving mathematics education and pupils' achievement.

It was stated in discussion during the workshop that the measures should comprise primarily:

- intensive examination of the influences that have caused the current situation;
- support to schools and regions where the pupils reach below average results,
- methodological support to all schools;

- development of mathematical (and reading) literacy in all subject matters in primary and secondary education;
- introducing specific support programmes;
- integration of a degree in developing mathematical literacy to teacher education programmes; and
- in-service training of teachers.

England

1.What is the national policy for, and structure of, mathematics education provision for 16-18/19 year-old (pre-university level) learners?

From the age of 16 education is non-compulsory in England. Students must apply for admission to specific programmes at this level. Around 40% of the age group in education and training will take A-levels, where each subject is made up of two parts, each designed to be studied over one year, AS and A2. Each part requires assessment in independent modules, either two or three. At the end of the first (AS) year students can choose to be awarded an AS level as a standalone qualification in a subject or continue their study to achieve a full A-level. Courses are designed so that typically students undertake AS levels in four subjects and continue at A2 in only three of these, but some students take more and some less than this. A-levels are an ISCED[1] Level 3 qualification and the most widely recognised for university admission.

Schools and colleges set their own admissions criteria, but commonly ask for a minimum of five GCSE[2] passes at grades A*, A, B or C for admission to A-level courses. These often include the achievement of GCSE passes at specified grades in the subjects to be studied at A-level.

AS/A-levels and several other types of qualifications offer mathematics at this level:

QUALIFICATION	DETAILS
A-level / AS Level	– Mathematics – Further Mathematics – Statistics
Free Standing Mathematics Qualification (Advanced)	Students can take one or more FSMQ (each roughly equivalent to one-third of an AS level) which contribute towards an AS level. The qualifications also provide UCAS points, which are used for university admission.
Diploma (Advanced Level)	The Advanced Diploma is A-level 3 qualification for people who want to go to university, or into skilled employment. These are currently available in any of 14 broad vocational areas. Only a few (e.g. engineering) have a specified mathematics component. However all students need to pass the three Functional Skills assessments in English, mathematics and ICT at level 2. (Functional Mathematics is not available at level 3).

A number of alternative qualifications are available but small numbers take these. They include academic qualification with entries mainly from the independent sector, such as the Cambridge Pre-U (similar to A-levels but without a modular structure) and the International Baccalaureate (where mathematics is a compulsory component but is available at three levels). There are also a number of qualifications more narrowly focused than the Diplomas, such as the National Vocational Qualifications (split into five levels, with the third level comparable to A-levels) or the BTEC Diploma (equivalent to three A-levels). These do not include standalone mathematics

1 International Standard Classification of Education (ISCED)

2 The General Certificate of Secondary Education usually taken at the end of lower secondary education.

qualifications at this level, but like Diplomas may feature elements of mathematics depending on the chosen course.[3]

Some students in post-compulsory education are taking independent one-year mathematics courses at level 2 or below if they have not already achieved this; most of these are repeating GCSE mathematics courses but some are studying for Functional Skills or Adult Numeracy Qualifications.

2. What are the overall participation rates in mathematics study for 16-18 year-olds both as proportions of students and proportions of the age cohort?

In the 2008/09 academic year, there were approximately 2,017,500 16-18 year olds in England. Of these, 79.7% were in education or training.[4] The table below shows the numbers of mathematics entries at AS and A2 in 2009.[5]

QUALIFICATION	TOTAL ENTRIES
AS-Level Mathematics	95,407
AS-Level Further Maths	12,710
A-Level Mathematics	66,552
A-Level Further Maths	10,073

About 9% of A-level exams sat were in Mathematics and about 1% were in Further Mathematics. The best measure uses data that matches candidates to examination subjects. An analysis of matched candidate data for A-level participation in mathematics compared to other subjects was only available for 2007 and not compared to overall participation in education and training.[6]

The following figures for England are therefore approximate but based on matched candidate data. Forty three per cent of the age cohort took A-levels. Twenty five per cent of those taking A-level took mathematics (AS or A2). Thus approximately 11% of the age cohort took advanced mathematics. Since approximately 80% of the age cohort are in education and training, about 13% of the education and training cohort took mathematics at A-level. This may slightly underestimate current participation levels, which (based on examinations data) appear to have improved in more recent years.[7]

3 The International Baccalaureate (IB) is also available and has a compulsory mathematics element but is taken by less than one % of students.

4 http://www.dcsf.gov.uk/rsgateway/DB/SFR/s000849/SFR12_2009v2.pdf

5 From: JCQ [Joint Council for Qualifications] 2009 A-level Results http://www.jcq.org.uk/attachments/published/984/JCQ%2DA%2DLevel.pdf

6 This calculation is based on Matthews & Pepper (2007): JCQ data. Matthews, A., & Pepper, D. (2007). *Evaluation of participation in GCE mathematics: Final report. QCA/07/3388*. London: Qualifications and Curriculum Authority.

7 See Appendix 1. Similar calculations based on both JCQ data (see Footnote 5 above), Noyes (2009) and Matthews & Pepper (2007) produce very similar estimates.

Apart from A-levels, a small proportion of students at upper secondary level take other qualifications in mathematics. There are aggregate data for 2006/7 Key Skills Application of Number for England, Wales and Nothern Ireland for 16-18 year olds: Total 106,800 (of which Level 1: 66,800; Level 2: 37,300; Level 3/4: 2,700).[8] Additionally, some students re-take GCSE, the pre-upper secondary examination. Although insufficient data was available, this amounts to perhaps a further 10% of the Education and Training cohort.

What are the patterns of participation in terms of following different routes involving mathematics?

Of the 2008/9 16-18 cohort achieving Level 3 qualifications, 69.5 % took A/AS levels, 3.5 % took an Applied A-level, 0.9 % took the International Baccalaureate, 22.2 % took a BTEC/OCR qualification and 3.5 % took an NVQ/VRQ0.[9] Free-Standing Mathematics Qualifications or "Use of Mathematics" qualifications are available at Level 1, 2 and 3, although numbers taking these qualifications are relatively small (in 2008: approx 3000 at Level 1, <500 at Level 2, 2000 at Level 3).[10] In practice, the majority of those studying mathematics either take an academic specialist route or take what is effectively "remedial" mathematics.

3. What is the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

Of the three main mathematics qualification routes, AS/A-levels focus on pure mathematics with applied options in mechanics, statistics or decision mathematics. They are at an advanced level and geared towards complex technical use of mathematics in a traditional approach to STEM subjects in higher education, although they are taken by many students who will not study these subjects.

Among the 16-18 age group, Level 3 Free Standing Maths Qualifications are intended to bridge the gap between GCSE and A/AS level and are often taken by students who have achieved their GCSE a year early. They mainly follow the principal content areas of the AS-level but have a more applied orientation.

The Functional Skills qualifications (taken either on their own or as part of a diploma) are intended to cater to uses of mathematics either in some vocational area or in everyday life.

4. What drives the pattern of take-up? How is it linked to the needs of HE, employers and national policy objectives?

Recent changes to mathematics qualifications have the expressed intention of meeting the needs of HE and of employers.[11] Although students will usually need to satisfy the entry requirements of the school or college, student take-up of post-16 mathematics is largely self-

8 Table 3 of http://www.education.gov.uk/rsgateway/DB/SFR/s000783/index.shtml

9 http://www.dcsf.gov.uk/rsgateway/DB/SFR/s000906/SFR02_2010.pdf

10 web.aqa.org.uk/over/stat_results_archive.php (June 2008)

11 Edexcel / King's College London. (2006). Developing curriculum pathways in mathematics: Phase One. Final Report. London: Ecexcel / KIng's College London. Advisory Committee on Mathematics Education, A. (2005). Report on an ACME workshop on '14–19 Mathematics Pathways', 13 October 2005. London: The Royal Society.

selecting. For example, although a number of career paths or degree programmes such as mathematics or engineering may require applicants to have an A-level in mathematics, it is viewed as beneficial for many other courses (e.g. computer science, economics, medicine or physics) but is not generally mandatory. For degree programmes with a high level of competition for places it may confer an advantage over other qualifications.

5. How is the picture changing over time?

The number of entries for A-level mathematics has fluctuated over the last 13 years. The absolute number of entries dramatically fell in 2002 after a syllabus change, but numbers have increased steadily since then, as shown in the table below.

A-level entries in Maths, Further Maths and All Subjects from 1995/96 to 2008/09[12]

ACADEMIC YEAR ENDING	TOTAL A-LVEL ENTRIES		
	FURTHER MATHS	MATHS	ALL SUBJECTS
2009	9,443	64,519	757,697
2008	8,447	57,618	741,356
2007	7,241	53,331	718,756
2006	6,516	49,805	715,203
2005	5,192	46,034	691,371
2004	5,111	46,017	675,924
2003	4,730	44,453	662,670
2002	4,498	44,156	645,033
2001	5,063	54,157	681,553
2000	5,015	53,674	672,362
1999	5,145	56,100	680,048
1998	5,211	56,589	681,082
1997	4,999	56,050	662,163
1996	4,913	54,125	620,164

Note, however, that, whilst there has been an increase in the number of A-level entries in mathematics, the size of the A-level cohort has also increased. The proportion of mathematics entries compared to total entries in 2009 is very similar to that of 1996. The proportion of entries in Further Mathematics is small, although this data suggest a recent increase, following an initiative aimed at increasing participation.

12 Includes ungraded, no award (absent/declined) and pending; http://www.dcsf.gov.uk/rsgateway/DB/SFR/s000906/SFR02_2010.pdf Note: DCSF data differs slightly from JCQ data.

Appendix 1:

Alternative calculations based on Noyes (2009) and on Matthews & Pepper (2007).

A: Figures from Noyes, A. (2009). Exploring social patterns of participation in university-entrance level mathematics in England. Research in Mathematics Education, 11(2), 167-183.Note: Noyes data set refers to West Midlands region only (PLASC data) and as a result may slightly underestimate England as a whole.

2007 DATA	
Y11 2005 Cohort Total	12,1524
Of total completing ANY A/AS-levels by 2007	41,176
Of total completing at least AS Mathematics by 2007	11,176
Of those taking ANY Advanced Level Qualifications take AS Mathematics or more	27.1%
Of the age cohort take ANY Adv Level Qualifications or more	33.9%
Of the age cohort take AS Mathematics or more	9.2%

2007 EDUCATION & TRAINING (E&T) COHORT AS A PERCENTAGE OF TOTAL AGE COHORT	ESTIMATE	% OF E&T TAKING ADVANCED MATHS
80%	97,219	11.5%
78% [as in DCSF SFR 12/2009]	94,789	11.8%

B. Figures from QCA Report: Matthews, A., & Pepper, D. (2007). Evaluation of participation in GCE mathematics: Final report. QCA/07/3388. London: Qualifications and Curriculum Authority.

2006 DATA	
% of age cohort taking A-level	43.2%
% of A-level students taking A-level Maths (Table 8, p.29)	18.6%
% of A-level students taking AS Maths only (not A2) (Table 10, p.31)	6.3%
% of A-level students taking advanced maths[13]	24.9%
% of age cohort taking advanced maths	10.8%
% of E&T cohort taking advanced maths	13.4%

13 By summing the A2 and AS figures above.

Estonia

1. What is the national policy for, and structure of, mathematics education provision for 16-18/19 year-old (pre-university level) learners?

Education is compulsory until students have completed nine years of basic education or reached the age of 17. To complete basic education, students have to pass three final centrally-set internal examinations. One of these must be in Estonian language and literature or Estonian as a second language, the second in mathematics, and the third a choice from the following subjects: Russian language and literature, English, German, French, Russian, biology, chemistry, physics, geography, history or civics. Students then receive a school-leaving certificate, which is required for entrance to upper secondary general or vocational education for ages 16-18/19 (three years).[1]

In 2008, just under two thirds of students completing basic education went into upper secondary general education, just under one third went into upper secondary vocational education and the remainder (0.6%) did not enter upper secondary education in 2008. However, it should be noted that about 14% of students leave education at 17 without completing basic education in Estonia.[2]

In upper secondary general education, the national curriculum determines a list of compulsory subjects, including mathematics. These subjects account for about 80% of instructional time, of which about 12% is allocated to mathematics.[3] To complete upper secondary general education, students have to pass five examinations. At least three must be national, external exams, of which one must be in mother tongue Estonian or Russian and the other two must be in subjects that students choose from the following list: mathematics, a foreign language, physics, chemistry, biology, history, geography, and civics. The final two exams can be external or internally set and marked in schools and students are free to choose the subjects. In fact, students may choose to be examined in more than five subjects. The examinations provide the basis for entry to higher education and, to some extent, to the labour market.[4]

In upper secondary vocational education, the curriculum is more decentralised but based on occupational standards and harmonised nationally. In addition, one third of instructional time must be spent on general education subjects (if they have not previously completed upper secondary general education), with about 12% of this time again allocated to mathematics.[5] However, more time can be allocated to mathematics, as for other compulsory subjects,

1 http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/eurybase_full_reports/EE_EN.pdf

2 Data provided by The National Examinations and Qualifications Centre.

3 The national curriculum actually determines the number of compulsory courses per compulsory subject. A course is defined as a 35-hour unit of study. In total, there are 72 compulsory courses in Estonian-language schools and 81 in Russian-language schools. In both cases, there are 9 compulsory courses in mathematics.

4 http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/eurybase_full_reports/EE_EN.pdf and additional details from The National Examinations and Qualifications Centre.

5 Upper secondary vocational education is usually 120 weeks in duration. Forty weeks must be spent on general education subjects. The content of 32/33 of these weeks is common to all vocations. Four of these weeks will be spent on mathematics and, according to specific vocations, possibly some of the remaining 7/8 weeks.

according to the vocation.[6] These students can also take examinations in upper secondary general education subjects in order to progress to vocational courses in higher education institutions. Whether they are in upper secondary vocational or general education, students must study mathematics but they can choose whether they take an examination in the subject. However, for some higher education courses they must pass the national mathematics examination.[7]

2. What are the overall participation rates in mathematics study for 16-18 year-olds both as proportions of students and proportions of the age cohort?

The following table provides early data on entries for the 2010 national, external exams in mathematics and other subjects. It includes entries from general and vocational students, and those re-sitting exams. Data on schools' internal exams are not collected.

All entries for national, external examinations, 2010

SUBJECT	TOTAL ENTRIES
Estonian (first language)	10,347
English	8,619
Geography	7,006
Civic studies	6,183
Mathematics	4,812[8]
Estonian (as an additional language)	3,463
Biology	3,424
Chemistry	2,156
History	1,896
Russian (first language)	1,741
Physics	776
German	389
Russian (as an additional language)	368
French	37
Total entries	51,217

These figures show that just under 10% of entries for external examinations are for mathematics. There is currently only an examination for the extended syllabus. This is difficult to

6 http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/eurybase_full_reports/EE_EN.pdf

7 Information provided by the National Examinations and Qualifications Centre.

8 Only 330 of these entries were from students in vocational schools and 356 entries were from students re-taking the examination.

interpret in terms of participation as the number of external examinations each student takes varies. However, all students (except a small number of vocational students taking these general examinations) must take the external examination in their mother tongue language (12,088 students). Thus a little less than 40% of upper secondary students were entered for the external examination in mathematics. It should be noted that since this is provisional data based on registration for the exams, it is not directly comparable to the previous years of data provided for question 6.[9]

3. What are the patterns of participation in terms of following different routes involving mathematics?

There are compulsory mathematics curricula for all upper secondary students.

Approximately 5% of students taking the national, external examination in mathematics are upper secondary vocational students. Vocational students will also be examined separately on specific aspects mathematics in cases where it is relevant to their vocation.[10]

4. What is the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

The content and level of mathematics in upper secondary general education typically comprises the following nine courses, which are compulsory for all students:

- Real numbers, equalities and inequalities
- Trigonometry
- Vectors in a plane and equations of a curve
- Sequence and functions
- Functions (exponential, logarithmic, periodic, trigonometric)
- The limit and derivative of a function
- Probability theory and statistics
- Stereometry and vectors in space
- Integrals.

In addition to these courses, schools may offer some students an extended syllabus.

In upper secondary vocational education, the compulsory mathematics syllabus includes:

- Real numbers and rational equations
- Trigonometry, sector, vectors on a plane, negative angle, perpendicular/collinear vectors
- Equation of a line, sequences (arithmetic, geometric), functions (even, uneven), investigation of functions
- Lim, derivatives, stereometry
- (Optional) functions II (negative step, exponential function, logarithmic equations).

9 The National Examinations and Qualifications Centre provided all the data for this section.

10 Information provided by the National Examinations and Qualifications Centre.

So, in essence, it is the first five topics of the nine in general education. In addition, according to the vocation, further topics may be taught. This is often statistics but could also be, for example, applied mathematics for business or logic and discrete mathematics for IT specialists.[11]

5. What drives the pattern of take-up? How is it linked to the needs of HE, employers and national policy objectives?

There has been some public controversy surrounding the external upper secondary general education mathematics examination. This first began several years ago when teachers noted that average results in mathematics were significantly lower than in other subjects. This precipitated a slight decline in the number of students choosing to enter themselves for the mathematics examination. With their school's position in national league tables in mind, some teachers may have discouraged some lower-attaining students from taking mathematics. The latest data show that students who take the national exam in maths averaged 52% in the maths exam but 63% across their national exams (which would be somewhat higher if their result in mathematics was excluded).

By choosing to be examined in subjects other than mathematics, students have sought to maximise their overall result, which is important for access to higher education and necessary for some university courses. As a consequence, there has been a shortage of students for higher education courses that require mathematics. Although all students continue to study mathematics in upper secondary level, it is generally held that if they do not choose to take the national examination in the subject then they will not have focussed on the required learning outcomes- or at least their outcomes are not known. There is a proposal to make compulsory the external examinations in mother tongue language (or Estonian as an additional language), mathematics and a foreign language from 2013. There would only be internal examinations other subjects. There would be two tiers in mathematics. The current examination would be retained and an easier examination would be created. For some higher education courses, the higher tier would be needed and for others, the lower tier would be needed.[12]

6. How is the picture changing over time?

The following table compares the number of students taking the compulsory national examination in their mother tongue language and the number of students taking the national examination in mathematics between 2004 and 2009. Since the data include both general education students and a smaller number of vocational and re-sitting students, the comparison is indicative rather than precise.[13]

11 The National Examinations and Qualifications Centre provided all the information for this section.

12 This section is based on information provided by the National Examinations and Qualifications Centre.

13 This section is based on data provided by the National Examinations and Qualifications Centre.

All students

YEAR	LANGUAGE	MATHEMATICS	PERCENTAGE OF STUDENTS TAKING THE LANGUAGE EXAM WHO ALSO TOOK THE MATHEMATICS EXAM
2004	13,371	6,916	51.72
2005	13,594	6,934	51.01
2006	13,590	6,334	46.61
2007	13,806	5,513	39.93
2008	13,182	4,690	35.58
2009	13,029	4,908	37.67

The next table provides the same comparison but for students in upper secondary general education only. Since students taking mathematics will generally have taken the mother tongue examination in the same year, this is a more precise comparison.

Students in upper secondary general education

YEAR	LANGUAGE	MATHEMATICS	PERCENTAGE OF STUDENTS TAKING THE LANGUAGE EXAM WHO ALSO TOOK THE MATHEMATICS EXAM
2004	12,037	6,475	53.79
2005	12,437	6,559	52.74
2006	12,686	6,028	47.52
2007	12,935	5,035	38.93
2008	12,473	4,514	36.19
2009	12,326	4,678	37.95

Finland

1. What is the national policy for, and structure of, mathematics education provision for 16-18/19 year-old (pre-university level) learners?

General upper secondary school

Half of 17-18 year olds attend upper secondary school leading up to the matriculation examination. General upper secondary education is mainly organised without division into grades, and teaching is not tied to year classes. The scope of the syllabus is three years but the studies may be accomplished in two, three or four years; the students may proceed in their studies either as a group or individually. Around 82% of all students complete upper secondary school in three years and 7% in four years.

It is fairly common for students to spend a year in another country as an exchange student and take a gap year from their upper secondary school education. Most students (82%) complete the qualification when they are 19 years old. More students complete it when they are 20 years old (12%) than when they are 18 (2%).

About two thirds of the courses that students take in upper secondary school are the same for everyone. All students study mathematics. They can choose either advanced or basic syllabus in mathematics. Advanced syllabus mathematics accounts for 13% of the studies for the upper secondary school qualification (for a student who does not take additional studies beyond what is required) and basic syllabus mathematics accounts for 8%.

Students who wish to study additional courses in mathematics can have up to 17% of their qualification made up of mathematics if they choose the advanced route and 11% if they choose the basic route.

Students must take at least four matriculation examinations. Mother tongue is a compulsory examination. The other three must be chosen from a list of four subjects or subject areas, one of them being mathematics.

Vocational upper secondary school

Around 43 % of 17-18 year olds attend vocational upper secondary school. Around 62% complete vocational upper secondary school in three years or less and 6% in four years.

Mathematics is one of nine core subjects that are studied for all qualifications. Each core subject is three credits (one credit is equal to 40 hours studies). The core subjects account for one sixth of the qualification.

2. What are the overall participation rates in mathematics study for 16-18 year-olds both as proportions of students and proportions of the age cohort?

Half of 17-18 year olds study in upper secondary school where mathematics is a compulsory subject for all. Around 43% study in vocational upper secondary school. All vocational qualifications have the same nine core subjects and mathematics is one of them.

3. What are the patterns of participation in terms of following different routes involving mathematics?

In upper secondary school all students study mathematics. Four in ten students choose the advanced syllabus in mathematics (52% of males and 35% of females).

It is not compulsory to take a mathematics matriculation examination. In spring 2009, 96% of those who studied advanced syllabus in mathematics and 63% of those who studied basic syllabus in mathematics took the relevant exam.

4. What is the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

The basic mathematics syllabus is designed to acquaint students with the models of mathematical thinking and the basic ideas and structures of mathematics, teach them to use mathematical language both orally and in writing and develop their calculation and problem-solving skills.

The advanced mathematics syllabus provides students with the mathematical capabilities required in vocational studies and higher education.[1] In advanced mathematics studies, students will be given opportunities to adopt mathematical concepts and methods and to learn to understand the nature of mathematical knowledge. In addition, instruction will aim to give students a clear understanding of the significance of mathematics to the development of society and of its applications in everyday life, science and technology.

5. What drives the pattern of take-up? How is it linked to the needs of HE, employers and national policy objectives?

One factor that motivates students to take the mathematics matriculation examination in upper secondary school is that the results can help them gain entry to a university course. University faculties have their own selection systems which are typically composed of points from the matriculation examination and points from the university faculty's own entrance test. The practice of each university and each faculty varies in how much they credit the matriculation examination, for which subjects and how they compile their own entrance examination.

1 http://www.oph.fi/instancedata/prime_product_julkaisu/oph/embeds/47678_core_curricula_upper_secondary_education.pdf

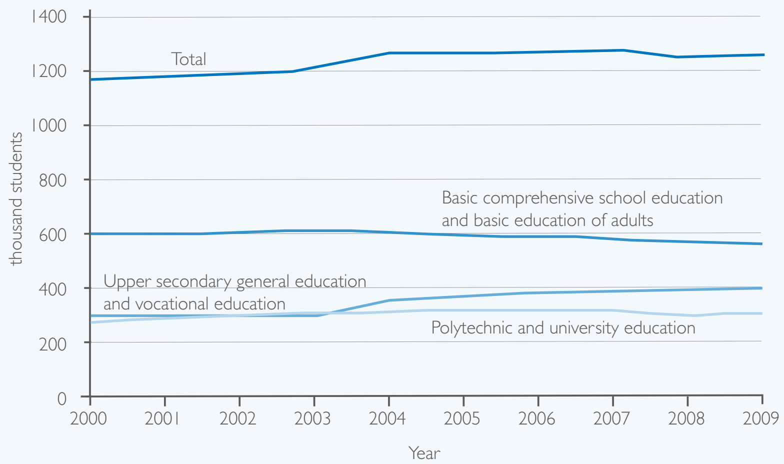
For example, for veterinary science in the University of Helsinki, 60% of the maximum total points come from the faculty's entrance exam whereas for biological and environmental sciences only 42% come from that faculty's entrance exam. The rest come from different subjects in the upper secondary school matriculation examination.

Most faculties give some points for the results in the matriculation exam in mathematics, and advanced mathematics is usually awarded more points than basic mathematics. However, a good grade in basic mathematics can get as many points as a lower grade in advanced mathematics. For example, a student wishing to study pharmacy in the University of Helsinki can get 19% of the maximum entrance points with the top grade in the advanced mathematics matriculation examination, or 9% with the top grade in the basic mathematics matriculation examination. Only 6% of students both in advanced and basic mathematics get the top grade in the matriculation exam.

The mathematics matriculation examination can help students get university places for arts subjects as well as science subjects. For example, 10% of the maximum entrance points for admission to the University of Helsinki's Faculty of Arts come from having the top grade in advanced mathematics, or 7% with the top grade in basic mathematics.

6. How is the picture changing over time?

Students in education leading to a qualification or degree 2000-09 (2009 preliminary data)



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France

1. What is the national policy for, and structure of, mathematics education provision from 16-18/19 year old (pre-university level) learners?

Compulsory education is for 6 to 16 year olds. Post-compulsory upper secondary education is provided at a general and technological *lycée* (LEGT; 15-18 year olds), or a vocational *lycée* (LP; 15 to 17/19 year olds).

In the first year of upper secondary education, students take a broad range of subjects before specialising in a chosen group of subjects or areas of study in the second year. This takes the form of a general or technological Baccalaureate in general and technological education and a vocational Baccaleareate, professional aptitude certificates (CAP) or professional study certificates (BEP) in vocational education.

The general Baccalaureate usually leads to higher education, as does the technological Baccalaureate for three out of four students, whereas the vocational Baccalaureate may lead to either higher education (for almost one out of four students) or employment.

The General Baccalaureate has three strands: economic and social (ES); literary (L); science (S). ES and S have mathematics as a core subject but it is optional in the L strand.

The Technological Baccalaureate has many strands: science and technology management (TSG); industrial science and technology (STI); science and technology of the laboratory (STL); science and technology of health (ST2.S); and science and technology of agriculture (STAV). Mathematics is a compulsory course within all of these strands.

Vocational Baccalaureate has three main areas: manufacture; agriculture; and the service industry. Mathematics is a compulsory course within all of these areas. In the BEP, mathematics is one of the general courses that students must take. In the CAP, students must take the mathematics-sciences course.[1]

In summary, with one exception, mathematics is compulsory for all upper secondary students, whether they are in general, technological or vocational education. The exception is some students on the Literature strand of the General Baccalaureate, who may choose not to study mathematics.

2. What are the overall participation rates in mathematics study for 16 – 18 year olds both as proportions of students and proportions of the age cohort?

Over half of the cohort, approximately 65%, registered to follow the Baccalaureate.

1 http://www.inca.org.uk/france.html and http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/eurybase_full_reports/FR_EN.pdf

3. What are the patterns of participation in terms of following different routes involving mathematics?

About half of the students who register to follow the Baccalaureate take the general route. Approximately 30% who register follow the technological route, and the remainder follow the vocational route.

4. What is the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

In upper secondary education (15+) (ISCED 3), major reform is currently planned for the 2010/11 school year for 15- to 16-year-olds and for 2011/12 for pupils aged 16-18. This will include several innovations:

- Changes to the Baccalaureate exams – introducing more open exercises in which pupils will need to demonstrate their thinking/research even if this doesn't achieve the desired result.
- From the age of 15, probability will have more importance than geometry.
- Algorithms will be integrated in Baccalaureate teaching.
- Scientific research methods, in addition to mathematical methods, will be introduced in the teaching of maths.
- The Inspectorate will expect to see mathematical experimentation in class, the integration of ICT, and the use of oral mathematical exercises.
- Weekly timetables for maths in the science Baccalaureate stream will be reduced from five to four hours from 2011.
- In some streams post-15, maths will no longer be a compulsory subject.

5. What drives the pattern of take-up? How is it linked to the needs of HE, employers and national policy objectives?

In principle, students who successfully complete Baccalaureate courses may enter higher education. The upper secondary maths reforms described above aim to better prepare pupils for higher education.

6. How is the picture changing over time?

The proportion of Baccalaureate graduates has increased from 3% of the cohort in 1945 to 25% in 1975 to 65.6 % in 2009. The numbers of graduates has increased since 2008 in general and vocational tracks, and decreased in the technological route.

In the academic year 2001-2002:

- 628,875 candidates were registered to take the Baccalaureate
- 52% were registered for the general Baccalaureate

- 29% for the technological Baccalaureate
- 18% for the vocational Baccalaureate.

In the academic year 2002-2003:

- just over 52% cent for the general Baccalaureate
- almost 30% for the technological Baccalaureate
- 18% for the vocational Baccalaureate.

In the academic years 2008 and 2009

PERCENTAGE OF BACCALAUREATE ENTRANTS ACHIEVING A PASS		
	2008	2009
applicants	621,521	625,700
recipients	518,895	539,100
pass rate	83.5%	86.2%

The success rate in 2009 is:
88.9 % to the general baccalaureate
79.8 % for the technology baccalaureate
87.3 % for the vocational baccalaureate.

For the general, breakdown by series:
87.2 % in literary (L)
88.6 % in economic and social (ES)
89.6 % in science (S).

For the technological, breakdown by series:
81.3 % in series science and technology management (TSG)
78.8 % in series industrial science and technology (STI)
86.7% in series science and technology of the laboratory (STL)
74.1 % in series science and technology of health (ST2.S).

For the vocational, breakdown by series:
87.1 % production (manufacture and agricultural)
87.5 % services.[2]

2 http://www.education.gouv.fr/

Germany

1. What is the national policy for, and structure of, mathematics education provision for 16-18/19 year-old (pre-university level) learners?

Full-time education is compulsory between the ages of 6 and 15 or 16 (depending on the region), and part-time education is compulsory until the age of 18 for those who do not attend a full-time school.

From the age of 16 students will be enrolled either in a general upper secondary school or in vocational education. These may be full time, or in the case of *Duales System – Berufschule + Betrieb* (Dual System: part-time vocational school and part-time on-the-job training) a mixture of schooling and job based training. Compulsory curricula/syllabuses exist for all subjects, as do areas of study in all types of (full- and part-time) compulsory school.[1]

SCHOOL	AGE	LEAVING CERTIFICATE
General upper secondary school (*Gymnasiale Oberstufe*)	15/16-18/19	Abitur
Full time vocational education (*Berufsfachschule or Fachoberschule*)	15/16-18	Zeugnis der Fachgebundenen Hochschulreife or Fachhochschulreife
Part-time vocational school and part-time on-the-job training (*Duales System – Berufschule + Betrieb*)	15/16-18/19	Zeugnis der Fachgebundenen Hochschulreife

Students attending *Gymnasium* must study subjects from three areas:

- languages, literature and the arts;
- social sciences;
- mathematics, natural sciences and technology.

They choose from basic and advanced courses, with a minimum of two courses at advanced level. Typically a student may take two advanced and five basic courses. One advanced course must be either German, continuation of a foreign language, mathematics, or a natural science. If German is the first advanced course, mathematics or a foreign language must be included among the four subjects taken in the *Abitur* examination. In addition, German, a foreign language and mathematics (regarded as 'key skills') must be taken at the upper level of the *Gymnasium*. Results from these three subjects must also be taken into account in the certificate of the general higher education entrance qualification (*Allgemeine Hochschulreife*).[2]

For students attending vocational school, the compulsory curriculum varies between courses. Students attending a *Berufsfachschule* (which introduce their students to one or several occupations) will have 60% of their classes focused on the skills needed to do their job, and the remainder will cover general education subjects: German, social studies, economics, religion, and

1 http://www.inca.org.uk/1430.html

2 http://www.inca.org.uk/1430.html

sport. In *Fachoberschulen* (general and specialised theoretical and practical knowledge and skills), instruction is given in the following subjects: German, foreign language, mathematics, natural sciences, economics and society, and a field-specific subject.

2 What are the overall participation rates in mathematics study for 16-18 year-olds both as proportions of students and proportions of the age cohort?

Participation in mathematics, courses in general and advanced level, upper secondary schools (general education schools), year 2008

PUPILS	2008	
Total number of pupils:	929,180	-
Mathematics, general level:	344,622	37.1 %
Mathematics, advanced level:	228,400	24.6 %
Total studying mathematics:	573,022	61.7%

Eurydice provides wider information on student numbers.[3] General education refers to *Gymnasium* students. Technical vocational education refers to *Fachoberschule* and *Berufliche Gymnasien/Fachgymnasien* students. The total education and training cohort excludes students in training who have already completed upper secondary education.

3. What are the patterns of participation in terms of following different routes involving mathematics?

Pupils can choose among a certain number of subjects of the field "natural sciences, mathematics and technology" in all general education schools.

4. What is the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

Students in a *gymnasiale oberstufe* will take mathematics at either a general or advanced level, depending on their chosen subjects. The general course is aimed at providing students with a broad understanding of mathematics, while the advanced course is intended to serve as an in-depth introduction to academic study. A general course will contain around three hours of teaching each week, while an advanced course will have between five and six hours.

Vocational courses involving mathematics will be tailored towards the individual requirements of the associated profession, and as such will range from everyday uses of mathematics, to advanced mathematics for subjects such as engineering.

3 http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/eurybase_full_reports/DE_EN.pdf

Further information about the content and level of advanced mathematics curricula is available from regions directly.

5. What drives the pattern of take-up? How is it linked to the needs of HE, employers and national policy objectives?

Take-up of mathematics for students in general education is driven largely by university admission requirements. Prior to 2004, students completing the *Abitur* were granted access to any course of study and all subject areas at universities and higher education institutions. However, a decision by the Standing Conference of the Ministers of Education and Cultural Affairs of all the *Länder* allowed universities to select up to half their intake. This allows them to require specific grades in individual subjects, and to hold entrance exams and interviews.

For students in vocational education, take-up will be governed largely by the compulsory content of their course.

6. How is the picture changing over time?

PARTICIPANTS IN GENERAL AND ADVANCED MATHEMATICS IN UPPER SECONDARY SCHOOLS (GENERAL EDUCATION SCHOOLS) IN 2003 AND 2008[4]

	NUMBER OF PUPILS IN 2003 (TOTAL 740,418)	PERCENTAGE OF TOTAL	NUMBER OF PUPILS IN 2008 (TOTAL 929,180)	PERCENTAGE OF TOTAL
General mathematics	268,980	38.8%	344,622	37.1 %
Advanced mathematics	177,402	24.0%	228,400	24.6 %
All mathematics	464,382	62.7%	573,022	61.7%

4 Provided by the Secretariat of the Standing Conference of the Ministers of Education and Cultural Affairs of the Lände, and the Federal Statistical Office.

Hong Kong

1. What is the policy for, and structure of, mathematics education provision for 16-18/19 year-old (pre-university level) learners?

There are only three years of compulsory schooling in secondary school in Hong Kong. However most students do at least five years (equivalent of leaving at 16 in UK).

At age 17 there is selection for sixth form education by the Hong Kong Certificate of Education Exams (HKCEE) - equivalent to GCSEs. Mathematics is compulsory up to this level. In the sixth form students take advanced level examinations – mathematics is optional at this level. These subjects may be taken in English or Chinese.[1]

Current qualifications

QUALIFICATION	DETAILS
Hong Kong Advanced Level exams (HKALE)	– Advanced Level Applied Mathematics – Advanced Supplementary Level Applied Mathematics – Advanced Level Pure Mathematics – Advanced Supplementary Level Mathematics and Statistics
Hong Kong Certificate of Education Examination (HKCEE)	– Mathematics – Additional Mathematics (optional)

The HKCEE and HKALE are in the process of being phased out over the 2009-2012 period. These are being replaced by the Hong Kong Diploma of Secondary Education (HKDSE). The final HKCEE exams will be in May 2010. The final Advanced Level exams will be in May 2012.

Hong Kong is changing its present system of five years (secondary up to equivalent of GCSE) + two years (equivalent of A-levels) + three years (university) to a system that is six years (Up to HKDSE) + four years (university).

Under the new system there will be three years of junior secondary education (S1-3), followed by three years of senior secondary education (S4-6) culminating in the HKDSE at the end of the third year (S6) of senior secondary schooling.[2] All students will have the opportunity to study up to S6. The new system commenced at S4 in September 2009.

New qualifications

Mathematics is one of the four core subjects: Chinese Language, English Language, Mathematics and Liberal Subjects.

1 http://www.edb.gov.hk/FileManager/EN/Content_689/edsys_e.pdf

2 http://www.tuition.com.hk/education-system.htm

QUALIFICATION	DETAILS
Hong Kong Diploma of Secondary Education (HKDSE)	– Compulsory Part – Extended Part – Module 1 (Calculus and Statistics), Module 2 (Algebra and Calculus) Extended Part is optional and students are allowed to take at most one module

2. What are the overall participation rates in mathematics study for 16-18 year-olds both as proportions of students and proportions of the age cohort?

With the introduction of the new curriculum all students will study mathematics for the HKDSE.

Under the current system, there were 72,242 "Day school first attempters" of HKCEE. Of these about 42% will continue into the sixth form.

The table below shows the numbers of entries for each of the main qualifications.

QUALIFICATION	TOTAL ENTRIES (DAY SCHOOL CANDIDATES)	APPROXIMATE SIZE OF AGE COHORT	APPROXIMATE TOTAL ENTRIES AS PERCENTAGE OF AGE COHORT	APPROXIMATE TOTAL ENTRIES AS PERCENTAGE OF COHORT IN EDUCATION OR TRAINING
HKCEE - Mathematics	82,186	86,000	95%	95%
HKCEE – Additional Mathematics	20,587	86,000	24%	24%
HKALE - A Level Applied Mathematics	931	86,000	1%	3%
HKALE - A Level Pure Mathematics	6,685	86,000	8%	23%
HKALE - AS Level Applied Mathematics	876	86,000	1%	3%
HKALE - AS Level Mathematics & Statistics	5,916	86,000	7%	20%

3. What are the patterns of participation in terms of following different routes involving mathematics?

In the new system, all students will take Mathematics. About one-third of students will take one module in the Extended Part which is optional.

4. What is the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

The Compulsory Part in Mathematics takes up 10-12.5% of total lesson time available. The Compulsory Part together with the Extended Part takes up 15% of the total lesson time. The modules in the Extended Part are designed for students who intend to learn Mathematics in greater depth or study in programmes that require a solid foundation of mathematical knowledge in future.[3]

5. What drives the pattern of take-up? How is it linked to the needs of HE, employers and policy objectives?

All four core subjects of the secondary school curriculum – Chinese Language, English Language, Mathematics and Liberal Studies – are to be considered as the mandatory minimum requirements for university entrance.

In general, institutions would consider the application of students who have attained Level 3 for Chinese Language and English Language and Level 2 for Mathematics and Liberal Studies in the HKDSE (the new qualification) for admission to four-year undergraduate programmes under the New Academic Structure. There are different entry requirements for different tertiary courses and a large number of students also apply to study abroad.

With the change in the new curriculum the policy objective of the HKSARG is that all students will study maths up to the end of secondary school education.

6. How is the picture changing over time?

With the introduction of the new curriculum all students will take the HKDSE. In comparison with major Asian and western countries it was found that mathematics topics are on average introduced to students two years earlier in Hong Kong. The new curriculum is designed to be learner focussed, broad and balanced and aims to provide students more confidence in mathematics and the ability to apply generic skills to solve mathematics problems.

Hong Kong aims to move away from the exam driven, content based education system to one that emphasises the values, attitudes, processes of learning and generic skills.[4]

3 http://www.edb.gov.hk/FileManager/EN/Content_6157/c2.pdf

4 http://math.unipa.it/~grim/SiLam.PDF

Hungary

1. What is the national policy for, and structure of, mathematics education provision for 16-18/19 year-old (pre-university level) learners?

Free and compulsory education starts at the age of five and ends at the age of 18 (although in special cases students can finish at 16). Vocational education and training starts at the age of 16. There are three types of school, ranging from purely academic to those focussed on specific skills.

Students do not have to take an exam at the end of school, but most choose to take a baccalaureate. The baccalaureate has four compulsory subjects: mathematics; Hungarian language and literature; a foreign language; and history. Other subjects can be selected.

Upper secondary students studying for a baccalaureate or university exam are taught various levels of mathematics in 3-6 classes each week. Some students specialise in other subjects but are not permitted to drop mathematics completely.

The baccalaureate has two levels - standard and advanced. Students at advanced level are awarded more points, making university entry easier. Some vocational qualifications also require mathematics.

The table below shows the four types of compulsory education to the age of 18. *Gimnázium* and *Szakközépiskola* are more academic, and *Szakiskola* and *Szakiskola* (remedial) are more vocational.[1]

1 http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/national_summary_sheets/047_HU_EN.pdf (page 5)

EDUCATION TYPE	AGE	QUALIFICATION TAKEN (ISCED 3) IN UPPER SECONDARY
1. Gimnázium	10/12/14-18/19	Baccalaureate
2. Szakközépiskola	14-17	General education and preparatory classes with vocational orientation
	17-18/19	General education plus preparatory classes and practical classes in school with vocational orientation
	18/19	Baccalaureate (studies can be continued in the same school or another one. Students can participate in vocational education and training, or continue their studies at ISCED level 5)
3. Szakiskola	Option 1	
	14-16 (general)	General education
	16-18/19/20 years	Vocational phase (vocational education and training)
	Option 2	
	14-16/17	General and vocational education and training
	16/17-18/19/20	Vocational education and training
4. Szakiskola (remedial)	14/15/16-18/19/20	Special general and vocational education (two + two years)

2. What are the overall participation rates in mathematics study for 16-18 year-olds both as proportions of students and proportions of the age cohort?

The table below shows the numbers of students in the different types of full-time education in 2007/2008.[2]

PHASE/PUPILS	GIMNÁZIUM	SZAKKÖZ-ÉPISKOLA	SZAKISKOLA	SPECIAL SZAKISKOLA	TOTAL
Boys	82,779	127,345	77,590	5,985	293,699
Girls	11,7247	114,671	45,602	3,788	281,308
Total	200,026	242,016	123,192	9,773	575,007

In May/July 2009 the total number of Baccalaureate exams due to be taken (without absentees or exemptions) was 525,867. All students take mathematics and marks are awarded from 1-5. A mark of 1 is a fail, and 2-5 are passes. The average mark achieved for the standard mathematics

2 http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/eurybase_full_reports/HU_EN.pdf (p150)

Baccalaureate was 3.07 (49.8% of exams taken). The average mark for the advanced mathematics Baccalaureate was 4.66 (72.8% of exams taken).

The tables below show the number of exams taken at each level and how well students performed by percentage score and marks (1-5).

Standard level (89,793 exams taken in 2009)

STANDARD LEVEL EXAM RESULTS BY PERCENTAGE SCORE (FROM A TOTAL OF 89,739 EXAMS TAKEN IN 2009)										
Result	**0-9%**	**10-19%**	**20-29%**	**30-39%**	**40-49%**	**50-59%**	**60-69%**	**70-79%**	**80-89%**	**90-100%**
Number of exams	603	143	17,786	15,069	16,080	10,836	10,938	6,553	6,908	4,877
Percentage of totals	0.67%	0.16%	19.81%	16.78%	17.91%	12.07%	12.18%	7.30%	7.69%	5.43%

STANDARD LEVEL EXAM RESULTS BY MARK 1-5 (FROM A TOTAL OF 89,739 EXAMS TAKEN IN 2009)					
Result	**1 (fail)**	**2**	**3**	**4**	**5**
Number of exams	746	32,855	26,916	17,491	11,785
Percentage of total	0.83%	36.59%	29.98%	19.48%	13.12%

Advanced level (2,357 exams taken in 2009)

ADVANCED LEVEL EXAM RESULTS BY PERCENTAGE SCORE (FROM A TOTAL OF 2,357 EXAMS TAKEN IN 2009)										
Result in %	**0-9%**	**10-19%**	**20-29%**	**30-39%**	**40-49%**	**50-59%**	**60-69%**	**70-79%**	**80-89%**	**90-100%**
Number of exams	1	9	20	83	147	253	386	463	555	440
Percentage of total	0,04%	0,38%	0,85%	3,52%	6,24%	10,73%	16,38%	19,64%	23,55%	18,67%

ADVANCED LEVEL EXAM RESULTS BY MARK 1-5 (FROM A TOTAL OF 2,357 EXAMS TAKEN IN 2009)					
Result	**1 (fail)**	**2**	**3**	**4**	**5**
Number of exams:	15	35	168	295	1844
Percentage of total	0.64%	1.48%	7.13%	12.52%	78.24%

3. What are the patterns of participation in terms of following different routes involving mathematics?

Hungary has a national core curriculum (NCC), which specifies the percentage of time that should be spent on the ten areas of learning, but not the number of hours. The NCC does not prescribe concrete syllabuses but rather orientation for curricula developers. There are non-binding central recommendations (framework curricula) which provide guidelines for teaching hours, and most schools follow these.

Because education is compulsory until 18, all pupils have to study mathematics, as one of the ten areas in the NNC. In Grades 9 -10 this is 10-15% of teaching time. In Grades 11-12 this is 10% of teaching time.

Students in *Gimnázium* have 111 mathematics lessons per year in grades 9-11 and 128 mathematics lessons per year in grade 12. Students in *Szakközépiskola* have 111 mathematics lessons per year in grades 9-11 and 96 lessons in grade 12. In *Szakiskola*, it is left to each individual school to allocate general knowledge teaching time for individual subjects.[3]

4. What is the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

The baccalaureate is required if students are going on to higher education. The amount of mathematics studied depends on what the student chooses to specialise in, though all will have to do some mathematics.

Most students taking vocational studies will do some mathematics, although those with special educational needs may not be required to do so. This may be deemed general mathematics.[4]

5. What drives the pattern of take-up? How is it linked to the needs of HE, employers and national policy objectives?

Take-up is linked to whether students wish to pursue higher education, or the type of employment they are aiming for. The national policy objectives mean that nearly all students will be studying some mathematics up to the age of 18.

6. How is the picture changing over time?

The baccalaureate has recently changed to the current two level system of standard and advanced.

3 http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/eurybase_full_reports/HU_EN.pdf (p.132)

4 http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/national_summary_sheets/047_HU_EN.pdf

Ireland

1. What is the national policy for, and structure of, mathematics education provision for 16-18/19 year-old (pre-university level) learners?

Compulsory education in Ireland is up to 16 years. There are four main types of school for secondary school students: secondary schools; community schools; comprehensive schools; and vocational schools. Education is mostly free, funded by the state, although 2% of students attend private schools, and 5% of secondary schools charge fees.

Students spend two or three years if continuing with post-compulsory education – known as the senior cycle (15-17/18 years). The optional transition year is offered in 72% of schools and delivers a school designed curriculum. During their last two years students take a Leaving Certificate programme. Some students will only take the Transition year programme. If students are taking one of the Leaving Certificate programmes the transition year is optional.[1]

There are three separate Leaving Certificate programmes determined at national level as described in the table below. Approximately 5% of students take the Leaving Certificate Applied programme. There is also the Post Leaving Certificate (PLC) which students can take after completing the Leaving Certificate.[2]

The Leaving Certificate programmes consist of a range of subjects and modules. Students taking the Leaving Certificate can study mathematics as a subject which contains many conceptual elements. Students can also take applied mathematics, but uptake of this subject is quite low.

For the Leaving Certificate, students can study mathematics at either higher (honours) or ordinary (pass) levels. There is also a foundation level course for mathematics which is aimed towards students who may have difficulty studying mathematics at the higher levels. The foundation level mathematics was introduced in 1995.

Students do not have to study mathematics to gain their Leaving Certificate – however if they wish to go on to HE they need to look carefully at the requirements for the courses they are interested in. Mathematics is a requirement for many courses in nearly all Irish third level (HE) institutions. Some courses, such as engineering, have a minimum requirement of a grade C in higher level mathematics.[3]

1 http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/national_summary_sheets/047_IE_EN.pdf

2 http://www.inca.org.uk/1842.html#324

3 http://www.citizensinformation.ie/categories/education/state-examinations/established_leaving_certificate

QUALIFICATION	DETAILS
Leaving Certificate (LC)	– Most widely taken programme. – Students take at least five subjects, one must be Irish unless students have entered the system after 11 years of age, or have been granted an exemption.
Leaving Certificate Vocational Programme (LCVP)	– Introduced in 1989. – Similar to the LC but added vocational content and concentration on technical subjects. – Students take five subjects, two of which are vocational. They also take a modern European language and three link modules on Enterprise Education, Preparation for Work and Work Experience.
Leaving Certificate Applied (LCA)	– Designed to prepare students for adult and working life. – If successfully completed students may continue with many Post Leaving Certificate courses. – Students take a number of modules under three general headings: general education; Vocational Education and Vocational preparation.
Post Leaving Certificate (PLC)	– Students can take this once their upper second level (equivalent to key stage 4) education is completed (from the age of 16). It is a one or two year course. – It consists of general education, vocational training and work experience. – It can also be taken part-time (under the Back to Education Initiative).

2. What are the overall participation rates in mathematics study for 16-18 year-olds both as proportions of students and proportions of the age cohort?

There are around 370,000 students in the second level education (compulsory and post-compulsory). Approximately 25% of students are educated at this level in vocational schools; 60% are in secondary schools; and around 13% are in community and comprehensive schools. Most students take mathematics at some level.

About 5% of students take the Leaving Certificate Applied (LCA). There are no separate figures available for the Leaving Certificate (LC) and Leaving Certificate Vocational Programme (LCVP).

3. What are the patterns of participation in terms of following different routes involving mathematics?

In 2008, 11.6% (5,803) students took foundation level mathematics, 71.4% (35,803) took ordinary level papers, and 17% (8,510) took higher level papers.

The table below shows the percentage of students achieving different grades for different mathematics levels.

MATHEMATICS LEVEL	A GRADE	C GRADE OR HIGHER	D GRADE	E, F OR NO GRADE
Higher	14.4%	82.3%	14.5%	3.2%
Ordinary	12.5%	67.4%	20.5%	12.3%
Foundation	9.8%	76.6%	17.6%	5.7%

Twenty six per cent of students received between 25-40 points, 20.7% received between 45-60 points, 7.8% achieved between 65-80 points, and 4.4% received 85-100 points. (The points awarded for different grades are shown in the table in section 4.)

In 2009, 8,420 students took the higher level mathematics, 37,273 students took the ordinary level mathematics, and 6,212 students took the foundation level mathematics.[4]

4. What is the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

Students taking the three year programme will generally perform better in the final examination and have greater flexibility if wishing to enter higher education. Students who wish to go on to HE usually take the LC and access to third level courses depends on the results (points gained) from the LC exams.

The aim of the senior cycle is to offer as broad an education as possible without too much specialisation.

Within a three year programme of study, a student will usually take a range of modules in the transition year, some of which facilitate their choice of subjects in the final two years leading to the Leaving Certificate examination in a range of subjects. Mathematics is almost universally one of these. For the two year programme, students generally study seven or eight subjects and mathematics is almost universally one of the subjects they take for examination. The subjects for examination are discrete areas taking 180 hours of study.[5]

Students taking the LCVP and the LCA are unlikely to go on to HE, and more likely to take more general mathematics.

Students are awarded points for their Leaving Certificate grades – based on their best six subjects. The maximum number of points they can achieve is 600. They can get 100 points maximum for each subject at a higher level, or 60 points for each subject at an ordinary level. Points are not awarded for foundation level grades, although some HE institutions award points for A and B grades in LC mathematics.[6] Some HE institutions award bonus points for higher level mathematics.

4 http://www.examinations.ie/statistics/statistics_2009/final_leaving_certificate_statistics_for_2009.pdf
See also other statistical information available here: http://www.examinations.ie

5 http://www.ncca.ie/uploadedfiles/SCycle%20Advice_0405.pdf
See also: www.curriculumonline.ie/en/Post-Primary_Curriculum/Senior_Cycle_Curriculum/ and:
http://www.education.ie/home/home.jsp?pcategory=17233&ecategory=17233&language=EN

6 http://www.educationireland.ie/index.php?option=com_content&view=article&id=268&Itemid=100170

5. What drives the pattern of take-up? How is it linked to the needs of HE, employers and national policy objectives?

Access to third level education (HE) is highly competitive in Ireland. Students compete for entry based on results achieved in the Irish Leaving Certificate Examination (LC). Students are awarded points on their six best subject scores. Entry requirements for courses may vary from year to year, depending on the number of places available and the number of applicants. There is a great deal of competition for the more sought after programmes.[7]

The LCVP, LCA and PLC are taken by students who wish to go into employment, or if they do well they may decide to progress to third level education.

6. How is the picture changing over time?

There has been much controversy over Leaving Certificate mathematics in recent years due to dwindling uptake of the higher level course and poor academic performance in the subject overall. In 2007, more than 40% of Leaving Certificate mathematics candidates received 20 or fewer CAO 8 points in the subject, out of a possible 100, with only 12% earning 65 points or more.

From 2005 to 2008 the participation rate in higher level mathematics has decreased from 18.9% to 17.0%.[9]

There is concern in Ireland that not enough students are opting to take mathematics and science at level 3 (post-16). The Republic's Education Minister has recently backed calls for a bonus points system for higher level mathematics in the Leaving Certificate to encourage more students to take up higher level mathematics.[10]

A curriculum and assessment initiative in mathematics for second level schools is currently underway in Ireland. This initiative, *Project Maths,* represents incremental reform to the mathematics syllabuses at both Junior Certificate and Leaving Certificate, with corresponding changes in the certificate examinations. Greater emphasis is placed on student understanding of mathematics concepts and on the application of mathematics knowledge and skills to solve problems based in real life contexts.[11] The change in curriculum and assessment is accompanied by an extensive programme of continuous professional development for mathematics teachers. The project began on a phased basis with an initial group of 24 schools in September 2008 and is scheduled to commence in all other schools in September 2010.[12]

7 http://www.educationireland.ie/index.php?option=com_content&view=article&id=35&Itemid=46

8 CAO is the Central Applications Office which is the organisation responsible for overseeing most undergraduate applications in the Republic of Ireland. The CAO is the organisation responsible for awarding points to the grades achieved for the various leaving certificate programmes.

9 http://en.wikipedia.org/wiki/Leaving_Certificate_Mathematics

10 http://www.belfasttelegraph.co.uk/breaking-news/uk-ireland/republics-education-minister-mary-coughlan-backs-maths-intake-plan-14758008.html

11 http:///www.ncca.ie/projectmaths

12 http://www.projectmaths.ie

Japan

1. What is the national policy for, and structure of, mathematics education provision for 16-18/19 year-old (pre-university level) learners?

Schooling in Japan is compulsory up to the age of 15. On completion of compulsory lower secondary school (*junior high school*), some students progress to general/academic upper secondary schools – *senior high schools* (others proceed to *colleges of technology, special training colleges* or *miscellaneous schools* – which are usually regarded as further/higher education). Students may take upper secondary courses full-time, part- time or by correspondence. Where courses in senior high schools are taken full-time, these normally last for three years. Upper secondary courses are classified into three categories: general; specialised; and integrated.

On completion of post-compulsory upper secondary education in senior high school, students receive a Certificate of Graduation from Upper Secondary Education (general, vocational, or integrated, dependent on the course followed). This is required for access to higher/further education in a junior college or university. Admission is not guaranteed by possession of the Certificate of Upper Secondary Education; institutions determine their own admissions procedures.[1]

Mathematics is compulsory for all students in post-compulsory upper secondary education. Other compulsory subjects are: Japanese language; Geography and History; Civics; Science; Health and Physical Education; Art; and Home Economics.[2]

2. What are the overall participation rates in mathematics study for 16-18 year-olds both as proportions of students and proportions of the age cohort?

In 2005, there were 4,337,031 16-19 year olds in Japan. Of these, 3,596,820 (83%) were in upper secondary education.[34]

Mathematics study in Japan comprises seven courses: *Basic Mathematics*; *Mathematics I*; *Mathematics II*; *Mathematics III*; *Mathematics A*; *Mathematics B*; and *Mathematics C*.

Upper Secondary students must take either *Basic Mathematics* or *Mathematics I*. Other courses are elective. It is estimated that 4% of students take *Basic Mathematics* and 99% of students take *Mathematics I*. The participation rates are estimated by dividing the number of first year students by the number of each textbook distributed.

For elective courses, 85% of students take *Mathematics II*, 20% take *Mathematics III*, 85% take *Mathematics A*, 50% take *Mathematics B* and 20% take *Mathematics C*.

1 http://www.inca.org.uk/1454.html

2 http://www.inca.org.uk/1467.html

3 http://www.mext.go.jp/english/statist/06060808/xls/041.xls

4 Figures from the 2005 census http://www.e-stat.go.jp/SG1/estat/ListE.do?bid=000001025191&cycode=0

Distributed number of mathematics textbooks in general course of upper secondary schools[5]

SUBJECTS	NUMBER OF TEXTBOOKS	RATIO OF PARTICIPANTS TO ALL STUDENTS (%)	RATIO OF PARTICIPANTS TO FIRST YEAR STUDENTS (%)
Basic Maths	55,406	1.5	4.6
Maths I	1,304,878	36.2	109.4
Maths II	1,016,273	28.2	85.2
Maths III	274,658	7.6	23.0
Maths A	1,019,606	28.3	85.5
Maths B	599,733	16.6	50.3
Maths C	251,501	7.0	21.1

Around 180 schools (approximately 3% of all upper secondary schools) provide a specialised course for Science and Mathematics, aimed at developing the abilities of students competent in these areas. There are three mathematical courses: *Science & Mathematics I*; *Science & Mathematics II*; and *Science & Mathematics research*. The first two are required study for students taking the specialised course.

Science & Mathematics I: the main content is from *Mathematics I* and *A*
Science & Mathematics II: the main content is from *Mathematics II* and *III*
Research Science & Mathematics: the main content is from *Mathematics B* and *C*

3. What are the patterns of participation in terms of following different routes involving mathematics?

The number of pupils studying each course is estimated in section 2.

4. What is the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

Following a review of the mathematics curriculum in 2009, the number of subjects has been reduced from seven to six. The following courses make up the revised mathematics curriculum:

Mathematics I will aim to ensure that students are equipped with the basic mathematics requirements for other subjects, as well as learning mathematics appropriate to upper secondary school. It is carefully designed both for students who may only take this course, as well as those who may continue to learn other mathematics courses.

5 http://www.mext.go.jp/b_menu/shingi/chukyo/chukyo3/004/siryo/06081417/004/006.htm

Mathematics II will aim to deepen *Mathematics I* and make systematic development towards *Mathematics III* in order to build mathematical qualities and abilities through learning the core content of upper secondary school mathematics.

Mathematics III will target the students who study mathematics more deeply with great interest and will in future deal with it on a specialist level.

Mathematics A will complement *Mathematics I* in reflecting on the content of lower secondary school mathematics. It will aim to foster the ability to think about events and phenomena mathematically and make students understand the value of mathematics.

Mathematics B will cover further content at an advanced level of *Mathematics I*. It will focus on the basic applications of mathematics in order to extend mathematical qualities and abilities of students who would make their career in natural and social sciences.

Applications of Mathematics will aim to foster the ability to think about events and phenomena mathematically and an attitude of willingness to apply mathematics - skills required in the knowledge-based economy. This is referred to as mathematical literacy. It also takes into consideration the development of mathematics having a close relationship with culture.

5. What drives the pattern of take-up? How is it linked to the needs of HE, employers and national policy objectives?

The typical course patterns of mathematics that full-time general course students take (under the Current Courses of Study) are as follows;

- Prospective students of science, mathematics and medicine in higher education take *Mathematics I*, *II* and *III* and *Mathematics A*, *B* and *C*.
- Prospective students of humanities and social sciences in higher education take *Mathematics I* and *II*, and *Mathematics A* and *B*.
- Other students take *Mathematics I, II* and *A*, or *Mathematics I* and *A*, or *Mathematics I* or Basic Mathematics.

6. How is the picture changing over time?

The Courses of Study, first prescribed in 1947, are usually revised around once every ten years.[6] A review started in 2009 underlined the following five points to foster:

- Mathematical activities
- Systematic understanding of mathematics as a core of mathematical thinking
- Ability to think and represent events and phenomena mathematically
- Appreciation of the value of mathematics
- Ability to make judgements when using mathematical reasoning.

The revision reduces seven subjects (*Basic Mathematics*, *Mathematics I*, *II*, *III*, *Mathematics A*, *B* and *C*) to six subjects (*Mathematics I*, *II* and *III* and *Mathematics A* and B and *Application of*

6 http://www.inca.org.uk/1467.html

Mathematics). The main content and credits of new subjects are shown in the table below. The main change is that *Mathematics I* now includes statistics and a new subject *Application of Mathematics* has been created.

SUBJECTS	STANDARD* NUMBER OF CREDITS	CONTENT OF STUDY
Mathematics I (compulsory)	3	– Numbers and Algebraic Expressions (Numbers and Sets, Expanding and – Factorizing algebraic expressions, Linear Inequality etc) – Quadratic Functions – Trigonometry – Data Handling and Analysis
Mathematics II	4	– Algebraic Expressions (Proofs, Binomial Expansion, Complex number, Equations of high degree etc) – Analytic Geometry (equations of circles, Locus and Region etc) – Trigonometric Functions,exponential Functions, logarithmic Functions, Calculus (Basic)
Mathematics III	5	– Parametric functions, Quadratic curve – Complex Plane – Limit – Calculus
Mathematics A	2	– Combinations and Permutations – Probability – Properties of Integer – Geometric propositions in two and three dimensions
Mathematics B	2	– Probability distributions and Statistical reasoning – Sequences and Series – Vector
Application of Mathematics	2	– Maths and human activities – Mathematical analysis of events/phenomena in social life

* Standard number of credits means the numbers of School/teaching hours per week. One school/teaching hour lasts normally 50 minutes.

Korea

1. What is the national policy for, and structure of, mathematics education provision for 16-18/19 year-old (pre-university level) learners?

From the age of 15, education is non-compulsory in Korea. After students have graduated from middle school in compulsory education, they can choose to attend general high school or vocational high school (agriculture and biotechnology, industry, business information, fishery, maritime transportation, home economics and vocational education). While high school education is non-compulsory, 99.6% of students transferred from middle school into high school in 2009. Of these, 75.5% attended general high school and 24.5% attended vocational high school.

Mathematics is compulsory in grade 10 (from age 15), but optional in grades 11 and 12 (ages 16-17). All students have to take Mathematics (general) in grade 10, and can then choose at least one subject from the science and technology subject cluster in grades 11 and 12.

A revised national mathematics curriculum was implemented from 2009 following a review in 2007. Students who entered high school before 2009 could choose from the science and technology subject cluster below:

SCIENCE AND TECHNOLOGY CLUSTER	SUBJECTS
Mathematics	Practical Mathematics, Mathematics I and II, Differentiation and Integration, Probability and Statistics, Discrete Mathematics.
Science	Life and Science, Physics I and II, Chemistry I and II, Biology I and II, Earth Science I and II.
Technology	Informational Society and Computer, Agricultural Science, Industrial Technology, Enterprise Management, Ocean Science, Home Science.

Students who entered high school in 2009 can choose from the subjects below:[1]

SCIENCE AND TECHNOLOGY CLUSTER	SUBJECTS
Mathematics	Applied Mathematics, Mathematics I and II, Calculus and statistics (elementary), Integration and Statistics, Geometry and vector.
Science	Physics I and II, Chemistry I and II, Life Science I and II, Earth Science I and II.
Technology	Agricultural Life Science, Engineering Technology, Home Economics, Enterprise Management, Ocean Science, Information.

1 The national curriculum guideline was revised in 2009. It will be implemented from 2011. From 2011, students in a general high school must take at least three from seven mathematics subjects including mathematics (general), and students in a vocational high school must take at least two.

2. What are the overall participation rates in mathematics study for 16-18 year-olds both as proportions of students and proportions of the age cohort?

In the 2009 academic year, there were approximately 692,465 16 year olds and 679,143 17 year olds in Korea[2]. Of these, 95.5% and 93.4% respectively were in high school. In order to achieve their certificate for high school graduation, students must attend more than 70% of their classes and take the mid- and final tests in all subjects, for which they are awarded a score.

All students in general high school and some students in vocational school study *Mathematics I*. The table below shows the numbers of entries for each mathematics subject in grades 11 and 12.

SUBJECT	TOTAL ENTRIES	APPROXIMATE SIZE OF AGE COHORT (16 AND 17 YEAR OLDS)	ESTIMATED SIZE OF COHORT IN HIGH SCHOOL	TOTAL ENTRIES AS PERCENTAGE OF AGE COHORT (%)	TOTAL ENTRIES AS PERCENTAGE OF COHORT IN HIGH SCHOOL (%)
Practical Mathematics	99,237	1,371,608	1,295,752	7.2	7.7
Mathematics I	536,284			39.1	41.4
Mathematics II	213,047			15.5	16.4
Differentiation and Integration	174,943			12.8	13.5
Probability and Statistics	293,373			21.4	22.6
Discrete Mathematics	55,381			4.0	4.3

Almost all high school students in grade 12 and some high school graduates take the College Scholastic Aptitude Test (CSAT) in order to enter university or college, although a few can be selected to enter university or college based on other criteria, such as high school score or a particular talent. Although Mathematics I is not a compulsory part of the College Scholastic Aptitude Test, it is seen by many students as advantageous to have a mathematics score when applying to their chosen university. There are two types of Mathematics: *Math A* and *Math B*. In 2009, there were 638,216 applicants for the Test, of which 93.9% of these took a mathematics test.

The table below shows test subjects and rates for *Math A* and B. *Math A* is generally (but not always) required for students studying engineering and natural science and *Math B* for humanities and social sciences.

2 The numbers of 16-17 year olds are estimated values from the 2005 census.

TYPE	TEST SUBJECT	NUMBER OF CSAT APPLICANTS †	PERCENTAGE OF TOTAL CSAT APPLICANTS †
Math A	Mathematics I Mathematics II One choice from three (Differentiation and Integration, Probability and Statistics, Discrete Mathematics)	137,073	21.5
Math B	Mathematics I	461,936	72.4
Total of Math		599,009	93.9
Total Applicants		638,216	100

† 'Applicants' refers to those taking a test in at least one subject

3. What are the patterns of participation in terms of following different routes involving mathematics?

Mathematics (general) is studied by all students in grade 10. The national curriculum is implemented in all schools in the high school course. All students in these courses have to study *mathematics (general)* and can study another mathematics subject if they want to. Numbers of students in each type of school are shown below.

CLASSIFICATION		NUMBER OF STUDENTS			
		TOTAL	NATIONAL	PUBLIC	PRIVATE
HIGH SCHOOL COURSE	Total	1,985,030	16,281	1,067,958	900,791
	General High School	1,484,966	11,012	802,651	671,303
	Vocational High School	480,826	5,269	247,529	228,028
	Air & Corr. High School	15,040	-	15,040	-
	Trade High School	1,236	-	-	1,236
	Miscellaneous School	2,769	-	2,677	92
	Civic High School	193	-	61	132
	Special School	23,720	1,056	10,652	12,012

4. What is the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

In Korea, all students in high school courses have to take mathematics (general). This subject is taught for four periods per week in grade 10 (one period is 50 minutes). Other mathematics subjects can be chosen freely according to students' interest, aptitude and career paths. There are not any other subjects deemed general mathematics. The mathematics courses that can be taken in grades 11 and 12 have been outlined previously.

5. What drives the pattern of take-up? How is it linked to the needs of HE, employers and national policy objectives?

University and College admission is via the College Scholastic Aptitude Test (CSAT). As a result, take-up of mathematics courses is governed by the content of the test.

Traditionally, excellence in (rather than the mastery of) both the Korean language and mathematics have been regarded as the basic or key skills in Korean education. The standards required to achieve 'excellence' or 'mastery' for each subject are defined in the Seventh National Curriculum. The mathematics standards will be defined by early 2011.

6. How is the picture changing over time?

The table below shows the number of applicants for each mathematics course, and the percentage of grade 12 applicants taking the College Scholastic Aptitude Test (CSAT) from 2004 to 2009. From 2004, the CSAT has been based on the Seventh National Curriculum. The percentage of grade 12 students applying to take the CSAT increased gradually up to 2009, as did applications for Math B. However, applications to take up Math A decreased. Although many students studied Mathematics II, Differentiation and Integration, they did not take Math A. Math A is more difficult than Math B. Additionally, some universities and colleges do not require a score in Math A from students studying engineering and natural science, or for students studying humanities and social sciences.

ACADEMIC YEAR	MATH A		MATH B		ALL CSAT APPLICANTS †	PERCENTAGE OF TOTAL CSAT APPLICANTS †
2009	137,073	21.5%	461,936	72.4%	638,216	78.8%
2008	121,828	21.8%	397,772	71.1%	559,475	76.4%
2007	122,533	22.3%	383,700	69.7%	550,588	76.6%
2006	117,273	21.2%	383,195	69.4%	551,883	72.3%
2005	131,769	23.8%	367,016	66.2%	554,345	71.1%
2004	145,823	25.4%	358,435	62.4%	574,218	71.6%

† 'Applicants' refers to those taking a test in at least one subject.

Netherlands

1. What is the national policy for, and structure of, mathematics education provision for 16-18/19 year-old (pre-university level) learners?

The Netherlands requires all young people up to 18 years old to attend school until they attain a basic qualification. A basic qualification is a HAVO, VWO or VMBO level 2 certificate:

Pre-university education (***Voorbereidend wetenschappelijk onderwijs*** – VWO)	Age 12 to 18
Senior secondary general education (*Hoger algemeen voortgezet onderwijs* – HAVO)	Age 12 to 17
Secondary vocational education (*Voorbereidend middelbaar beroepsonderwijs* – VMBO)	Age 12 to 16
Senior Secondary Vocational Education and Training (*Middelbaar Beroepsonderwijs* – MBO)	Age 16 to 20

Lower and upper secondary education in the Netherlands is divided into two cycles: the first cycle of basic secondary education, students aged 12-15, is common to all school types and the second cycle specifically prepares students for differentiated terminal examinations. Upper secondary general education is from age 15 to 17/18 in VWO and HAVO. Upper secondary vocational education is from age 14 to 18 in VMBO and 16 to 18/19/20 in MBO.[1]

VWO – Students taking the VWO route choose from one of four courses: science and technology (NT); science and health (NG); economics and society (EM); and culture and society (CM). Mathematics is a compulsory component in all courses

HAVO – Students taking the HAVO route choose from the same four courses, though the content of each course is different from VWO. Mathematics is a compulsory component in all courses except CM, in which it is optional (for students beginning from August 2007).

VMBO – The VMBO leaving examination is in two parts: a school examination and a national examination. For some subjects, i.e. physical education, social studies and arts I, there is a school examination only. The national examination consists of written exams and combined written and practical exams. All pupils take a written exam in general subjects including Dutch, mathematics and biology. Students who choose the theoretical option in VMBO take compulsory mathematics as part of their sector-specific programme.

MBO – Students graduating from the VMBO program may choose to enter an MBO course. For this reason, this document focuses on VMBO for vocational education. Vocational Education and Training (VET) is the main supplier to the labour market. Approximately 40% of the Dutch working population have completed a vocational course to at least a secondary vocational training level.[2]

1 http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/eurybase_full_reports/NL_EN.pdf

2 http://www.mboraad.nl/?category/126232/English.aspx

Compulsory subjects vary according to students' chosen pathways but Dutch, English, Social Studies and PE are compulsory across upper secondary general education (VWO and HAVO) and initial vocational education (VMBO).

2. What are the overall participation rates in mathematics study for 16-18 year-olds both as proportions of students and proportions of the age cohort?

Number of pupils in secondary education (x1000)[3]

	2006	2007	2008
Year 1 secondary	160.8	158.5	158.5
Year 2 secondary	162.7	162.0	160.4
VMBO basic vocational programme year 3	11.8	10.1	9.2
VMBO basic vocational programme year 4	12.5	10.6	9.3
VMBO middle-man. Vocational programme year 3	22.0	20.6	19.9
VMBO middle-man. Vocational programme year 4	22.1	20.9	19.8
VMBO theoretical programme year 3	36.0	34.7	34.2
VMBO theoretical programme year 4	42.5	42.0	40.8
VMBO combined programme year 3	12.9	13.0	13.2
VMBO combined programme year 4	6.3	6.8	6.7
VMBO total	**166.1**	**158.7**	**153.1**
HAVO year 3	40.5	40.0	39.8
HAVO year 4	55.7	58.0	58.3
HAVO year 5	45.6	47.3	47.5
HAVO total	**141.8**	**145.3**	**145.6**
VWO year 3	41.7	41.8	42.8
VWO year 4	41.6	42.8	42.9
VWO year 5	39.0	40.8	40.8
VWO year 6	33.6	35.8	38.2
VWO total	**155.9**	**161.2**	**164.7**
Total (mainstream, excl. special needs)	**793.8**	**792.1**	**788.8**
Total (mainstream secondary)	**905.9**	**905.6**	**900.1**

3 http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/eurybase_full_reports/NL_EN.pdf

3. What are the patterns of participation in terms of following different routes involving mathematics?[4]

Number of pupils by subject combination in the 5th year of HAVO (x 1000)

SUBJECT COMBINATION	2006		2007		2008	
	NUMBER	%	NUMBER	%	NUMBER	%
Total	**45**	**100**	**47**	**100**	**45**	**100**
Science & technology	4	9	4	9	5	10
Science & health	8	18	9	19	8	18
Economics & society	17	37	17	37	20	42
Culture & society	15	34	15	33	10	22
Combined s&t/s&h	1	2	1	2	3	5
Combined e&s/c&s	0	1	0	1	2	3

Number of pupils by subject combination in the 6th year of VWO (x 1000)

SUBJECT COMBINATION	2006		2007		2008	
	NUMBER	%	NUMBER	%	NUMBER	%
Total	**33**	**100**	**36**	**100**	**38**	**100**
Science & technology	4	13	5	14	5	13
Science & health	10	31	11	32	12	32
Economics & society	10	31	11	31	12	32
Culture & society	7	20	7	19	7	18
Combined s&t/s&h	1	4	2	4	2	5
Combined e&s/c&s	0	1	0	0	0	1

4. What are the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

Science and Technology is advanced mathematics as defined and applied in TIMSS Advanced.[5] TIMSS Advanced is an IEA study assessing student achievement in advanced mathematics and physics in the final year of secondary school— internationally, the twelfth grade. Both *Science and Health and Economics and Society* have standard mathematics. *Culture and Society* includes elementary mathematics in the VWO stream, and mathematics as elective in HAVO.

4 http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/eurybase_full_reports/NL_EN.pdf

5 http://timssandpirls.bc.edu/timss_advanced/index.html

The most recent examination programmes for the various forms of mathematics are available (in Dutch) from the Dutch Association of Mathematics teachers.[6]

5. What drives the pattern of take-up? How is it linked to the needs of HE, employers and national policy objectives?

As schooling is compulsory up to the age of 18 (unless students achieve one of the basic qualifications listed in section 1 earlier), take-up is influenced by the educational route chosen.

Entry to most higher education courses is on the basis of specific subject combinations but candidates who do not meet this requirement may still be admitted on the strength of certain optional subjects studied at school.[7]

6. How is the picture changing over time?

New, stricter examination requirements will apply from the 2011/2012 school year. Secondary school pupils will only receive a leaving certificate if their average mark for their national exams is a pass. In addition, they will not receive their certificate if they fail (mark of 5) in either Dutch, English or mathematics.

In 2009 the 'Deltaplan' was set up which will aim to improve the language and maths skills of students in vocational education.[8]

In 2007/2008 the rules regarding profile choice in the upper cycle in VWO and HAVO changed, making a combination choice of Science and Technology with Science and Health easier. This resulted in a significant increase in the share of students taking this combination in VWO as well as HAVO. The combination profile offers more choice for STEM studies.

6 http://www.nvvw.nl/page.php?id=1061

7 http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/eurybase_full_reports/NL_EN.pdf p.119

8 http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/national_summary_sheets/047_NL_EN.pdf p.12

New Zealand

Overview

Education is compulsory for all children between six and 16. Post-compulsory upper secondary students are catered for mostly in secondary schools. Most secondary schools cater for students aged 13-18 (Years 9-13).

State and state-integrated schools are required to develop and implement a curriculum based on the New Zealand Curriculum[1], that is, a curriculum:

- underpinned by and consistent with a set of Principles;
- in which the Values set out in the curriculum document are encouraged and modelled and are explored by students; and
- that supports students to develop a set of specified Key Competencies.

The specified Key Competencies are:

- Thinking
- Using language symbols and texts
- Managing self
- Relating to others
- Participating and contributing.

Schools must provide all students in years 1-10 with effectively taught programmes of learning in English, mathematics and statistics, science, technology, social sciences, the arts and health and physical education.

Students in Years 11 to 13 (ages 15/16 to 18) make personal choices from a wide range of courses, which lead to further study or to work and training opportunities. They also undertake studies in greater depth.[2]

1. What is the national policy for, and structure of, mathematics education provision from 16-18/19 year old (pre-university level) learners?[3]

The New Zealand National Curriculum covers Years 1-13 (though is not mandatory in years 11, 12 and 13).[4] Mathematics and Statistics is described via one page of introductory information

1 Approximately 96% of students attend state and state-integrated schools. Independent schools are not required to use the New Zealand Curriculum but most do follow it in whole or in part.

2 http://www.inca.org.uk/new-zealand-system-mainstream.html

3 http://nzcurriculum.tki.org.nz/National-Standards/Mathematics-standards and http://www.minedu.govt.nz/NZEducation/EducationPolicies/Schools/CurriculumAndNCEA/NCEA/NCEAAchievementStandards/NCEAAchievementStandardsAndMatrices.aspx

4 http://www.inca.org.uk/1281.html#5.4.2

and a series of Achievement Objectives specified at 8 levels of achievement covering the 13 years of schooling. There are three strands:

1. Number and Algebra

Number involves calculating and estimating, using appropriate mental, written, or machine calculation methods in flexible ways. It also involves knowing when it is appropriate to use estimation and being able to discern whether results are reasonable. Algebra involves generalising and representing the patterns and relationships found in numbers, shapes, and measures.

2. Geometry and Measurement

Geometry involves recognising and using the properties and symmetries of shapes and describing position and movement.

Measurement involves quantifying the attributes of objects, using appropriate units and instruments. It also involves predicting and calculating rates of change.

3. Statistics

Statistics involves identifying problems that can be explored by the use of appropriate data, designing investigations, collecting data, exploring and using patterns and relationships in data, solving problems, and communicating findings. Statistics also involves interpreting statistical information, evaluating databased arguments, and dealing with uncertainty and variation.

Most students completing compulsory education (aged 15 to 16) take the National Certificate of Educational Achievement (NCEA) which can include traditional school curriculum areas and alternative programmes. This is a credit-based qualification. Level 1 is usually completed at the end of compulsory education and must include literacy and numeracy[5]; level 3 on completion of post-compulsory upper secondary education (aged 17-18).

2. What are the overall participation rates in mathematics study for 16 – 18 year olds both as proportions of students and proportions of the age cohort?

PROPORTION OF STUDENTS AT SCHOOL BY AGE (2008)[6]	
Age 16 (end of compulsory education)	82%
Age 17	62%
Age 18	13%

5 http://www.nzqa.govt.nz/qualifications-standards/qualifications/ncea/understanding-ncea/how-ncea-works/ncea-levels-and-certificates/

6 http://seniorsecondary.tki.org.nz/Mathematics-and-statistics

For mathematics subjects the data for 1 July 2009 is as follows:

	ZONE YR 11 (MALE)	ZONE YR 11 (FEMALE)	ZONE YR 12 (MALE)	ZONE YR 12 (FEMALE)	ZONE YR 13 (MALE)	ZONE YR 13 (FEMALE)
Accounting	4,096	3,793	2,471	2,297	1,971	1,655
Mathematics	30,662	29,507	22,084	20,738	3,717	3,645
Mathematics (Remedial)	282	330	179	114	23	11
Mathematics with Calculus	20	17	245	264	5,145	3,125
Mathematics with Statistics	99	92	644	678	7,061	6,809
Total Year Group Cohort	32,017	30,812	26,814	27,440	21,638	23,203

Note: Zone means students studying at the typical level for that year even if they are older or younger. Cohort is based on a different count so relationship of subject numbers to cohort is not exact.

3. What are the patterns of participation in terms of following different routes involving mathematics?

See section 2.

4. What is the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

Information is available from the New Zealand Qualification Authority and the New Zealand Ministry of Education websites:

www.nzqa.govt.nz
www.minedu.govt.nz/NZEducation/EducationPolicies/Schools/CurriculumAndNCEA/NationalCurriculum/Mathematics.aspx

5. What drives the pattern of take-up? How is it linked to the needs of HE, employers and national policy objectives?

Results of the NCEA are recognised by tertiary institutions and employers.

The Ministry of Education commissioned research into the impact of the NCEA on student motivation. This was subsequently undertaken by researchers at Victoria University in the College of Education and the School of Psychology.

The final report, *The Impact of the NCEA on Student Motivation* (ISBN 0-478-13508-4), is available to download from the Ministry of Education website: **www.minedu.govt.nz/NZEducation/EducationPolicies/Schools/CurriculumAndNCEA/NCEA/TheImpactOfNCEAOnStudentMotivation.aspx**

6. How is the picture changing over time?

Reports show the percentages and numbers of Year 11 students on July 1 school rolls achieving the literacy and numeracy requirements for NCEA Level 1 – 2004-2009. Both single-year and cumulative views are available. The percentage achieving numeracy has risen steadily from 78.2% in 2004 to 85.8% in 2009.[7]

SUBJECT	F5		YR 11		YR 11		ZONE Y11	
	1987		1997		2002		2007	
Total students	62,467	%	53,812	%	55,837	%	62,832	%
Maths								
Maths	59,894	95.9	49,630	92.2	48,687	87.2	61,981	98.6
Maths with Stats								
Maths with Calculus								
Accounting	11,534	18.5	10,380	19.3	9,028	16.2	9,381	14.9

SUBJECT	F6		YR 12		YR12		ZONE Y12	
	1987		1997		2002		2007	
Total students	36,020	%	45,674	%	46,701	%	52,911	%
Maths								
Maths	28,009	77.8	32,777	71.8	29,954	64.1	43,167	81.6
Maths with Stats			858	1.9	1173	2.5	802	1.5
Maths with Calculus			1,091	2.4	995	2.1	481	0.9
Accounting	9,133	25.4	6,775	14.8	5,472	11.7	5,486	10.4

Note: Zone means students studying at the typical level for that year even if they are older or younger. Cohort is based on a different count so relationship of subject numbers to cohort is not exact.

7 http://www.nzqa.govt.nz/qualifications/ssq/statistics/provider-selected-report.do?reportID=2135179

Northern Ireland

1. What is the national policy for, and structure of, mathematics education provision for 16-18/19 year-old (pre-university level) learners?

From the age of 16, education is non-compulsory in Northern Ireland. Students must apply for admission to specific programmes at this level. The entry requirements for post-compulsory education and training programmes are set by the individual school, college or employer. In most cases specific grades and/or subjects at GCSE[1] (or in other approved qualifications) are required. There are also programmes available for students who have not achieved GCSE level qualifications by the end of compulsory education at 16.

Post compulsory education is provided by sixth forms in schools, or at colleges of further or higher education. The Northern Ireland curriculum does not apply to this level and students can choose from a wide range of courses and from open and distance learning. The content of courses for nationally recognised qualifications is determined by the awarding body. For most qualifications, the awarding body is the CCEA (Council for the Curriculum Evaluation and Assessment), although some students take English board qualifications. All the awarding bodies are subject to QCDA authority (Qualifications and Curriculum Development Authority). Students can take academic (general) or vocational courses or a combination of both. Schools tend to offer more academic courses, and colleges of further and higher education tend to offer a balance of both academic and vocational courses. GCE A levels (General certificate of education advanced level) are the qualifications most generally accepted for entry into further or higher education (from 18+). The qualification system in Northern Ireland is very similar to the English system.

Schools and colleges set their own admissions criteria for sixth form, but commonly ask for a minimum of five GCSE passes at grades A*, A, B or C for admission to A-level courses. These often include the achievement of good GCSE passes (usually grade C or above) in the subjects to be studied at GCE A-level.

1 The General Certificate of Secondary Education usually taken at the end of lower secondary education.

QUALIFICATION	DETAILS
GCE A level	– Mathematics – Further Mathematics Students must have studied GCSE mathematics to take the GCE A level. A study of GCSE additional mathematics is an advantage but not a requirement.
GCE AS level (general certificate of education advanced subsidiary qualifications)	– Mathematics – Further Mathematics These exams are worth half an A level in terms of points for entry to university. They cover the same breadth as an A level subject but in less depth, and allow students to broaden the number of subjects studied in sixth form.
A levels in applied subjects (formerly vocational certificates of education - VCE's)	– These are generally in more vocational subjects such as ICT, applied business studies, health and social care, technology and design.
Key skills certificates	– For mathematics these include 'Application of number' and 'Problem solving'. They can be taken at a range of levels – level 3 is available for the 16+ age group.
BTEC National	– These are courses covering a range of vocational subjects leading to vocational qualifications.

Some students aged 16–18+ may also choose to follow General Certificate of Secondary Education (GCSE) courses.[2]

2. What are the overall participation rates in mathematics study for 16-18 year-olds both as proportions of students and proportions of the age cohort?

In the 2008/09 academic year, 86.8% of 16 and 17 year olds in Northern Ireland were in full time education or vocational training in schools and FE colleges.[3]

Of the 24,091 school leavers in 2008, 44% (10,595) left with the equivalent of three or more A-levels, 2.7% (653) left with the equivalent of two A-levels and 2.2% (527) left with the equivalent of one A-level.[4]

The take up rate for A-level mathematics in England, Wales and Northern Ireland has been put at approximately 12% of 17 year olds.[5] The proportions of students who then gain grades A*- C is higher in Northern Ireland compared with the rest of the UK:[6]

- A-level mathematics – 89.1% gain grades A*- C (81.3% in the rest of the UK).
- A-level further mathematics – 92.2% gain grades A*- C (88.9% in the rest of the UK).

2 http://www.ccea.org.uk/mathematics/
http://www.rewardinglearning.org.uk/docs/quals/Quals_VQ_Poster_v4.pdf
http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/structures/041_UKNorthern%20Ireland_EN.pdf
3 http://www.deni.gov.uk/16_and_17_year_olds_particpation_rate_totals_-__time_series-2.xls
4 http://www.deni.gov.uk/highest_qualification_of_school_leavers_2004-08.pdf
5 http://www.score-education.org/downloads/state_of_the_nation/SNR2_Summary_September_2007.pdf
6 http://www.deni.gov.uk/report_of_the_stem_2009_review.pdf

The official 2009 report on A-level results in the UK indicates that of all A-level examinations sat in Northern Ireland that year, 8.8% were in Mathematics and 0.5% were in Further Mathematics. The percentage for Mathematics makes it one of the most popular subjects and is comparable to the 9% reported for A-level Mathematics in the UK as a whole (these data all incorporate AS and A2 results).[7]

3. What are the patterns of participation in terms of following different routes involving mathematics?

In 1995/6 there were 2,456 students who chose to take mathematics at A-level. This was 28% of the total 8,889 students who took STEM subjects (science, technology, engineering and mathematics).

Ten years later, in 2005/6, 2,302 students chose to take mathematics at A-level – 21% of the 10,723 students who took STEM subjects.

4. What is the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

GCE mathematics (A and AS level) usually leads students to higher education and can lead to success in careers such as accountancy, finance, statistics, computer programming, engineering, medicine, psychology, dentistry and teaching. For GCE mathematics, students can take modules in pure mathematics (core modules), mechanics and statistics. They can take these modules for both the A level and AS level.

Applied A levels are taught within a work related context and students have to demonstrate knowledge and skills that are relevant to a particular occupation or general area of employment. These could lead to HE or employment.

Key skills certificates are designed to give students a more general understanding of mathematics, while BTECs are specifically designed to lead students into vocational pathways.

5. What drives the pattern of take-up? How is it linked to the needs of HE, employers and national policy objectives?

Students are not required to study mathematics post-16, therefore take-up will be related to whether students have specific interests in mathematics for A-levels, particularly depending on what they may be interested in studying for higher education. For certain areas mathematics may be an advantage, such as science, physics, IT and engineering.

6. How is the picture changing over time?

Take-up of Further Mathematics has been declining by 3-4% a year from 2001 to 2008. There has also been a slight decline in the take-up of Mathematics[8].

7 http://www.jcq.org.uk/attachments/published/984/JCQ GCE Results 2009.pdf

8 http://www.deni.gov.uk/report_of_the_stem_2009_review.pdf

Russia

1. What is the national policy for, and structure of, mathematics education provision for 16-18/19 year-old (pre-university level) learners?

Education in Russia is compulsory up to the age of 15. Upper-secondary education is split between vocational and general schools.

The general route (referred to as *secondary (complete) general education*) begins at 15 and lasts two years. Most students will complete their secondary education at 17.

Students taking the vocational route start at 15 (after completing basic general education) or 17 (after completing *secondary (complete) general education*). This varies in length from 1 to 3.5 years depending on the time of entry and chosen institution.

General education

A Basic Curriculum for General Education has been developed which lays down the state requirements for the minimum content of education and the workload of students. The Basic Curriculum designates the compulsory fields of study as well as the time allocation for each subject as shown below.[1]

1 Http://www.ed.gov.ru/ob-edu/noc/rub/standard/ – This is the standard (2004 year) in force

BASIC CURRICULUM FOR BASIC GENERAL EDUCATION (NUMBER OF CLASSES PER WEEK FOR EACH GRADE)									
FIELDS OF STUDY	GRADES								
	I	II	III	IV	V	VI	VII	VII	IX
Russian	5	5	5	5	6	6	4	3	2
Literature	4	4	3	3	2	2	2	2	3
Foreign language	0	2	2	2	3	3	3	3	3
Mathematics	4	4	4	4	5	5	5	5	5
Informatics and ICT								1	2
Social sciences					2	3	3	4	3
Natural sciences	2	2	2	2	2	2	6	8	8
Arts	2	2	2	2	2	2	2	1	1
Technology	1	1	2	2	2	2	2	1	0
Physical training	2	2	2	2	2	2	2	2	2
Total:	**20**	**22**	**22**	**22**	**26**	**27**	**29**	**30**	**29**
Regional options (6- days in a week)	(0)*	3	3	3	5	5	5	5	6
Mandatory load (6-days in a week)	(20)*	25	25	25	31	32	34	35	35
Regional options (5- days in a week)	0	0	0	0	2	2	2	2	3
Mandatory load (5-days in a week)	20	22	22	22	28	29	31	32	32
Number of weeks per academic year	33	34	34	34	34	34	34	34	34

For *secondary (complete) general education* there are two different levels of studying fields of study – Base and Advanced.

BASIC CURRICULUM FOR SECONDARY (COMPLETE) GENERAL EDUCATION				
FIELDS OF STUDY	NUMBER OF CLASSES PER WEEK			
	BASE LEVEL		ADVANCED LEVEL*	
	X GRADE	XI GRADE	X GRADE	XI GRADE
Russian	1	1	3	3
Literature	3	3	5	5
Foreign language	3	3	6	6
Mathematics	4	4	6	6
Social sciences	4	4	8	8
Natural sciences	3	3	3	3
Physical training	2	2	2	2
Total:	Not more then 30 / 30			
Regional options	2 / 2			
Institutional options (elective courses, educational practice, projects, research activity)	4 / 4			
Total:	36 / 36			
Mandatory load (6-days in a week)	36 / 36			
Mandatory load (5-days in a week):	35 / 35			

* Regional and institutional options give the possibility to give from 6 to 12 hours per educational week for advanced mathematics level.

In practice, each school designs its own curriculum, basing it upon the Basic Curriculum.

Primary general education and basic general education are compulsory. On the completion of basic general education (a nine-year programme), students take final examinations (the State final attestation) and are awarded, if they pass, the Certificate of Basic General Education (*Attestat ob Osnovnom Obshchem Obrazovanii*). As a result of the State final attestation, students may or may not be encouraged to continue their education. The Certificate entitles its holder to be admitted to either *secondary (complete) general education* or to vocational education, as well as to non-university level higher education.

The Certificate of *Secondary (Complete) General Education* (*Attestat o Srednem (Polnom) Obshchem Obrazovanii*) is awarded after the completion of an eleven-year school programme and the successful passing of the State final attestation (Unified State Examinations). A minimum of five disciplines are subject to final examinations: two federal compulsory written examinations (Russian and mathematics) and three optional examinations chosen by the student. In addition to the results of the State examinations, school leaving certificates include a supplement listing the grades obtained by students in all the subjects taught during the whole period of education.

Vocational education

There are two main types of vocational institutions in Russia - Professional Schools and Professional Lyceums.

Professional Schools are aimed at the acquisition of professional qualifications and mainly cover subjects for professional training. They offer courses from 1-2.5 years if entering after basic general education at 15, or 1-1.5 years if entering after secondary (complete) school at 17. Graduates are awarded a diploma that gives them the right to join a profession. Such a diploma also entitles its holder to pursue non-university level higher education (in case studies are pursued in the same profile, educational programmes can be shortened), however this type of vocational education does not give right of access to university level higher education.

Professional Lyceums combine the vocational component of the Professional School with the general education of *secondary (complete) general education*. They offer courses lasting a minimum of 3.5 years for basic general graduates starting at 15, and 1-1.5 years for students who have graduated *secondary (complete) general education* already. Graduates of a Professional Lyceum are awarded diplomas that not only give them the right to exercise a profession but also the right to be admitted to university level higher education institutions.[2]

2. What are the overall participation rates in mathematics study for 16-18 year-olds both as proportions of students and proportions of the age cohort?

Of the adult population (in 2005), 96% have completed lower secondary education and 78% also have an upper secondary education.[3] All of these will have completed some mathematics courses.

3. What are the patterns of participation in terms of following different routes involving mathematics?

In primary and basic schools all students study mathematics. In secondary (complete) school all students must study mathematics choosing one of two mathematics courses – base or advanced.

In grades 10-11 students taking the most advanced mathematics course (8-12 hours per educational week) in 2008 made up 1.4 % (29,672 students) of the entire corresponding age cohort (17 years) of graduates from 11th grade (2,073,041 students)[4].

2 http://en.russia.edu.ru/edu/description/sysobr/911/

3 http://www.uis.unesco.org/TEMPLATE/pdf/wei/WEI2005.pdf

4 Ina V.S. Mullis and others. TIMSS Advanced 2008 International Report: Findings from IEA's Study of Achievement in Advanced Mathematics and Physics in the Final Year of Secondary School. Publisher: TIMSS & PIRLS International Study Center, p. 29

4. What is the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

The official curriculum of the Advanced Mathematics Course (grades 10-11) is organic enhancement and deepening of the content of the topics included in the General Mathematics Course (grades 10-11). It includes some additional themes (e.g. the algebra of polynomials, the theory of divisibility), and solving of more intricate problems demanding deeper knowledge of the material studied in the General Mathematics Course. The enhancement and deepening of the advanced mathematics course are connected with the number of classes per educational week accepted in the concrete school.

Graduates are not required to study (at school) the Advanced Mathematics Course for entry to any university if they are able to pass the unified state mathematics examination.

5. What drives the pattern of take-up? How is it linked to the needs of HE, employers and national policy objectives?

The Russian education system has always given special attention to mathematics. Consequently, it is mandatory in all grades (1-11). In grades 8-9 students are permitted to study an advanced course to allow them to prepare for studying an advanced course in upper secondary school. In practice, not many schools provide advanced mathematics courses to upper secondary students, so most students study the general course.

In upper secondary school (grades 10-11), all students choose the level (base or advanced) of their mathematics course. All graduates of basic and upper secondary school pass a compulsory mathematics examination.

It is thought that knowledge of mathematics promotes successful integration with society. Therefore new standards designed to meet the requirements of a modern society are being developed.

6. How is the picture changing over time?

Between 1995 and 2008 the number of students in grade 10-11 studying advanced mathematics fell from 1.7% to 1.4% of the educational cohort.

Scotland

1. What is the national policy for, and structure of, mathematics education provision for 16-18/19 year-old (pre-university level) learners?

From the age of 16, education is non-compulsory in Scotland. Pupils who do not leave formal education at the end of S4 (end of ISECD 2) will either progress to ISCED 3, normally at the same secondary school, or will move to one of 42 further education (FE) colleges for ISCED 3 and 4 level National Qualifications (NQ) or Scottish Vocational Qualifications (SVQ) courses.[1] An increasing number of partnerships between schools, colleges and employers provide vocationally oriented National Qualifications for pupils before and after the end of compulsory education. In contrast with England, there are no entry requirements for continued education at secondary schools. Colleges may set their own requirements.

The Scottish National Qualifications Framework (SCQF) organises qualifications in Scotland into a hierarchy, ranking each qualification according to level. This allows both learners and employers to better understand the value of each qualification. As well as whole qualifications being certificated, it is possible to certificate individual units.

LEVEL(S)	SCQF LEVEL(S)	NATIONAL QUALIFICATION	SUBJECTS
5	7	Advanced Higher	– Applied Mathematics – Mathematics
3	6	Higher	– Mathematics
3	5	Standard Grade Credit level and Intermediate 2	– Mathematics
2	4	Standard Grade General level and Intermediate 1	– Mathematics
1	3	Standard Grade Foundation level and Access 3	– Mathematics
1	2	Access 2	– Mathematics
-	2-6	Core Skills	– Numeracy

1 http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/national_summary_sheets/047_SC_EN.pdf

2. What are the overall participation rates in mathematics study for 16-18 year-olds both as proportions of students and proportions of the age cohort?

Percentage of National Qualification entries by stage 2003[2]

	S4 (AGE 15-16)	S5 (AGE 16-17)	S6 (AGE 17-18)	TOTAL PERCENTAGE OF QUALIFICATION ENTRIES IN S4-S6
Intermediate 1	30%	57%	9%	96%
Intermediate 2	5%	72%	13%	90%
Higher	0%	63%	30%	93%
Advanced Higher	0%	0%	98%	98%

Standard Grades are predominantly taken in S4 and as such are not included below. Access courses precede the Intermediate courses and have been excluded for the same reason.[3]

2 http://www.inca.org.uk/1193.html

3 http://www.learningatschool.net

Entries at SCQF level 4-7 for 2008 and 2009[4]

QUALIFICATION	SUBJECT	ENTRIES 2008	ENTRIES 2009	PASS RATE 2008	PASS RATE 2009
Advanced Higher	Mathematics	2,752	3,027	70.5%	67.8%
	Applied Mathematics	305	305	77.7%	75.4%
	All subjects	18,854	19,648	77.9%	80.2%
	Mathematics as percentage of total	15%	15%	-	-
	Applied Mathematics as percentage of total	2%	2%	-	-
Higher	Mathematics	19,636	19,638	72.2%	70.3%
	All subjects	162,576	167,792	75.1%	76.0%
	Maths as percentage of all subjects	12%	12%	-	-
Intermediate 2	Mathematics entries	19,480	21,487	72.8%	72.0%
	Total entries	113,388	122,463	79.3%	79.7%
	Mathematics as percentage of total	17%	18%	-	-
Intermediate 1	Mathematics entries	12,650	12,082	60.2%	60.1%
	Total entries	60,267	65,735	74.8%	75.6%
	Mathematics as percentage of total	21%	18%	-	-

Entries at SCQF level 4-7 for 2009 compared to age cohort and cohort in education or training

QUALIFICATION	SUBJECT	ENTRIES 2009	ESTIMATED SIZE OF AGE COHORT (15-19)[5]	ESTIMATED SIZE OF AGE COHORT IN EDUCATION / TRAINING[6]
Advanced Higher	Mathematics	3,027	326,050	138,653
	Applied Mathematics	305		
Higher	Mathematics	19,638		
Intermediate 2	Mathematics	21,487		
Intermediate 1	Mathematics	12,082		

4 http://www.sqa.org.uk/sqa/36315.html

5 http://www.gro-scotland.gov.uk/statistics/publications-and-data/population-estimates/mid-year/mid-2009-pop-est/list-of-figures.html

6 http://www.scotland.gov.uk/Publications/2009/11/05112711/121

3. What are the patterns of participation in terms of following different routes involving mathematics?

Of students leaving upper secondary education in the 2008/09 academic year, 14.9% held level 7 qualifications, 32.4% held level 6 qualifications, 27.1% held level 5 qualifications and 19.3% held level 4 qualifications (based on highest level of qualification held at time of leaving).[7]

Of school leavers, 20.4% held mathematics qualifications at level 6, and 3.3% held mathematics qualifications at level 7.

4. What is the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

The Higher and Advanced Higher mathematics courses focus on pure mathematics, although the number of entries is very small. Students taking Applied Mathematics can choose from either mechanics or statistics. The applied options are all at an advanced level geared towards complex use of mathematics for study in higher education.

Standard Grade and Intermediate qualifications focus on pure mathematics, but up to 15% of candidates take the 'Applications of Mathematics' unit offered in Intermediate 1 and 2 instead of the pure mathematics unit 3. Access courses and core skills cater for more everyday uses of mathematics.

5. What drives the pattern of take-up? How is it linked to the needs of HE, employers and national policy objectives?

University admission drives take-up of the higher and advanced higher qualifications. Scottish universities tend to provide four year courses, which compensates for students starting university a year earlier than in England. Students who have stayed on for a sixth year at secondary school and taken Advanced Highers may enter directly into the second year of university.

Many degree courses such as engineering, physics and mathematics will require applicants to have taken the mathematics Higher paper, and may have grade requirements.

In other cases, students will pursue mathematics qualifications for their own interest without specific career or educational goals in mind.

Vocational qualifications such as the Scottish Vocational Qualifications are tailored to specific industry requirements, and any required mathematical content will be focused on how it will be applied for the particular vocation.

7 http://www.scotland.gov.uk/Publications/2010/03/22111037/39

How is the picture changing over time?

In 2002 the Scottish Executive embarked on an extensive consultation exercise on the state of school education - the 'National Debate on Education'. In response to the National Debate, Ministers established a Curriculum Review Group in November 2003. Its work resulted in the publication in November 2004 of 'A Curriculum for Excellence'.[8] Implementation of the Curriculum for Excellence is currently planned for school year 2010-2011.[9] A detailed summary of the Curriculum for Excellence mathematics programme is available from Learning and Teaching Scotland.[10]

8 Detailed information on the Curriculum for Excellence can be found on its website: http://www.ltscotland.org.uk/curriculumforexcellence/

9 http://www.scotland.gov.uk/News/Releases/2010/04/22164648

10 http://www.ltscotland.org.uk/curriculumforexcellence/mathematics/index.asp

Singapore

1. What is the national policy for, and structure of, mathematics education provision for 16-18/19 year-old (pre-university level) learners?

Upper secondary education, known as post-secondary (or pre-university) education in Singapore, caters for students aged 16/17 to 18/19/20, in four different types of school.

1. Junior colleges, which offer two-year pre-university courses leading to the Singapore-Cambridge General Certificate of Education Advanced Level (GCE 'A' Level) examinations and tertiary education.
2. Centralised institute, which offer three-year pre-university courses leading to the Singapore-Cambridge GCE 'A' Level and tertiary education.
3. Polytechnics, which offer three-year courses leading to a diploma.
4. Institute of Technical Education, which offers 1-2 year technical or vocational courses leading to skills certification to meet the workforce needs of various industry sectors.

Entry into upper secondary education is governed by attainment at lower secondary level, specifically Singapore-Cambridge General Certificate of Education Ordinary Level (GCE O Level) examination results. However, there are some schools that offer the Integrated Programme, where students proceed directly to post-secondary or pre-university education without sitting the GCE 'O' Level examination.

Post-Secondary or Pre-University Education

Junior College/Centralised Institute

Since 2006, the A level in Singapore[1] has been stratified into Higher 1, 2 and 3 (H1, H2 and H3) levels of study. H2 corresponds to the previous standard of A-level prior to 2006. H1 is half the size of H2 in terms of curriculum time. H1 subjects offer students breadth and sufficient depth for them to acquire foundational knowledge and skills in a subject area that will support their future studies at university level. H3 level subjects offer students a variety of learning opportunities (e.g. advanced content, research paper/project, and university module) to study a subject area in more specialised depth. Students who study H3 subjects must take the corresponding subject at H2 level. To ensure breadth of skills and knowledge, students are required to study at least one contrasting subject. For example a science student should take a subject from the arts or humanities, and vice versa.

Most pre-university students will study a combination of four GCE A Level subjects (three H2 subjects and one H1 subject, with at least one of these a contrasting subject), and compulsory subjects of General Paper, Mother Tongue Language, and Project Work. Students with the ability and passion for a particular subject can study an additional H1 or H2 subject, or up to two H3 subjects for deeper specialisation.

Mathematics is not a compulsory subject in the A-level curriculum. In general, most students study H2 Mathematics in preparation for university courses that require more advanced

1 http://www.moe.gov.sg/education/files/edu-booklet/edu-booklet-english.pdf

mathematics content, such as engineering, sciences and mathematics. Students who study H1 Mathematics tend to take it as a contrasting subject (mostly arts students) or to acquire foundational knowledge and skills required for university. Those with exceptional abilities in mathematics can study H3 Mathematics in addition to H2.

All students who complete their education at the secondary and pre-university levels will receive a comprehensive school testimonial called the School Graduation Certificate from the Ministry of Education. It includes a description of each student's academic and non-academic achievements and personal qualities.

Polytechnic and Vocational Education

Students can also choose to study three-year courses at a Polytechnic, leading to a diploma. These programmes are more practically based, but include subjects such as engineering, which require an advanced understanding of mathematics.[2] Vocational education is also provided by the Institute of Technical Education (ITE), which offers institutional training and traineeship programmes in areas ranging from engineering to technical to business. ITE courses lead to the National ITE Certificate (Nitec) or the Higher National ITE Certificate (Higher Nitec). Those who do well in these courses can proceed to the polytechnics to pursue diploma studies. The mathematics learned in these ITE courses is an extension of content covered in the GCE O Level Mathematics but in an applied area[3].

2. What are the overall participation rates in mathematics study for 16-18 year-olds both as proportions of students and proportions of the age cohort?

The table below shows the numbers of entries for each of the main qualifications that incorporate mathematics at A-level.

YEAR	TOTAL NUMBER OF CANDIDATES (FOR ONE A-LEVEL COHORT)	NO. OF STUDENTS (% OF TOTAL CANDIDATES)		
		H1 MATHEMATICS	H2 MATHEMATICS	H3 MATHEMATICS
2008	14,463	1,436 (9.9)	13,010 (90.0)	497 (3.4)
2009	14,212	1,346 (9.5)	12,748 (89.7)	366 (2.6)

2 http://www.sp.edu.sg/wps/portal/vp-spws

3 http://www.ite.edu.sg/ite/index_op.html

3. What are the patterns of participation in terms of following different routes involving mathematics?

The table below shows the numbers of students enrolled in different institutions in 2008.[4]

INSTITUTION	NUMBER OF STUDENTS
Pre-University / Centralised Institut[6]	32,579
Institute of Technical Education[7]	24,593
Polytechnics[8]	71,137

4. What is the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

Syllabi are available online for the three levels of mathematics courses in 2010 and 2011 – *Higher 1* (H1), *Higher 2* (H2) and *Higher 3* (H3).[8] These set out the aims and content of each course.

H1 Mathematics provides a foundation in mathematics for students who intend to enrol in university courses such as business, economics and social sciences. It covers Functions and Graphs, Calculus and Statistics. The main focus of the syllabus is the understanding and application of basic concepts and techniques of statistics. This is designed to equip students with the skills to analyse and interpret data, and to make informed decisions.

H2 Mathematics prepares students for university courses including mathematics, physics and engineering, where more mathematics content is required. The syllabus aims to develop mathematical thinking and problem solving skills in students. Topics covered include: Functions and Graphs; Sequences and Series; Vectors; Complex Numbers; Calculus; Permutations; Combinations and Probability; Binomial, Poisson and Normal Distributions; Sampling and Hypothesis Testing; and Correlation and Regression. Students learn to analyse, formulate and solve different types of problems. They also learn to work with data and perform statistical analyses.

H3 Mathematics provides for students who have a strong aptitude for, and are passionate about mathematics. It is taken alongside H2 Mathematics and provides an opportunity for students to further develop their mathematical modelling and reasoning skills. The topics included are Graph Theory, Combinatorics, and Differential Equations. Students are required to study all three topics and have opportunities to visualise and explore theorems, and to read and write mathematical proofs. Students will also learn the process of mathematical modelling for real-world problems, which involves making informed assumptions, validation and prediction.

4 http://www.moe.gov.sg/education/education-statistics-digest

5 Junior College Year 1 and Year 2 students and Centralised Institute Years 1 to 3 students.

6 institutional training, excluding traineeship programmes.

7 full-time diploma courses in all polytechnics.

8 http://www.seab.gov.sg/aLevel/syllabusSchool_Info.html See also: www.moe.gov.sg/education/pre-u

There are other H3 Mathematics programmes offered by local universities. This widens the choices for the students. These programmes are centred on Linear Algebra or Number Theory as the main focus.

5. What drives the pattern of take-up? How is it linked to the needs of HE, employers and national policy objectives?

A-level mathematics take-up is largely driven by university course requirements. A large number of courses require students to have passed mathematics at H1 or H2 level. For example, of a sample of 26 single degree courses (excluding a degree in Music) offered at the National University of Singapore[9], 11 require an H2 level pass, eight require an H1 or H2 pass as one of a choice of necessary qualifications, and two require an H1 level pass. The remaining five do not require a mathematics qualification.

Students in some polytechnics and vocational programmes will have mandatory mathematics components in their course as appropriate.

6. How is the picture changing over time?

This is the fourth year since the implementation of the 2006 Singapore-Cambridge GCE A-Level curriculum. As the cohort size varies from year to year, it might be premature to draw meaningful interpretation of the take-up of each mathematics course at this point. Generally, the take-up for H1 and H2 Mathematics has remained consistent, with about 99% of each A-level cohort taking either one of these two subjects.

9 http://www.nus.edu.sg/iw/resources/oam/misc/Category%20A%20Application%20Guide.pdf

Spain

1. What is the national policy for, and structure of, mathematics education provision for 16-18/19 year-old (pre-university level) learners?

Education is compulsory in Spain up to the age of 16. In the last year of compulsory secondary Education (15 years old), students have to choose one of two mathematics options - either one related to pure mathematics and natural sciences, or mathematical content related to social sciences.

After compulsory education, students wishing to continue their education can choose either vocational education or, for those interested in entering university, the Baccalaureate (*Bachillerato*).

Vocational education is divided into different modules related to professions and consists of two levels - middle and high. The former lasts two years and the latter around three. Mathematics is studied in some of those modules.

The Spanish *Bachillerato* (16-18 years old) has different pathways (Modalidades) which respond to students' interests (Ministerio de Educación y Ciencia, 2007):

- Arts (Artes)
- Science and Technology (Ciencias y Tecnologia)
- Humanities and Social Sciences (Humanidades y Ciencias Sociales)

There are compulsory common subjects for all of the above mentioned pathways. In addition, each pathway has its own group of specific optional subjects. Students must choose a number of these subjects, one of which is mathematics.

As in compulsory secondary education, there are two different types of mathematics in the Bachillerato. Students on the Science and Technology pathway study Pure Mathematics, and those on the Humanities and Social Sciences pathway study Mathematics applied to Social Sciences. Subject selection in the second year of upper secondary partly depends on the subjects chosen the previous year (students cannot select mathematics in the second year if they did not take maths in the first year).

Students must choose some subjects relevant to the university degree they plan to follow. For example Pure Mathematics is required for entry to engineering and scientific degrees, while Mathematics applied to Social Sciences is a subject required to study economy, management, psychology etc.

2. What are the overall participation rates in mathematics study for 16-18 year-olds both as proportions of students and proportions of the age cohort?

The data available on participation in mathematics relate to the university entrance exams (PAU) that follow successful completion of the *Bachillerato*. It should be noted that this system is due to change in 2010, but in 2009 students took exams in one of six areas: Science and Technology; Health Sciences; Social Sciences; Humanities; Arts; or Combined. The total number of students registered to sit the PAU was 204,178. Of these students, 85.54% passed (174,648).

3. What are the patterns of participation in terms of following different routes involving mathematics?

The two PAU options of Social Sciences and Science and Technology are both strongly related to mathematics. Although students taking other PAU options may take maths, these are the only two that require it. Of the students registered for the PAU exams in 2009, 54.8% took either the Social Sciences or Science and Technology option and were therefore examined in maths. [1]

In the same year (2009):

- 44,420 students were entered for Science and Technology (21.8% of the cohort of 204,178 students). This was the third highest number amongst the six qualifications. Of these students, 86.7% passed (38,508 students).
- 67,543 students were entered for Social Sciences (33.1% of the cohort). This was the highest number amongst the six qualifications. Of these students, 84.41% passed (57,014 students). The number of these students who chose mathematics as an elective subject is not available at national level.
- 53,080 students were entered for Health Sciences (26% of the cohort). This was the second highest number amongst the six qualifications. Of these students, 88.25% passed (46,843 students). However, the number of these students who chose mathematics as an elective subject is not available at national level.

Some students entered for the combined *Bachillerato* may also have studied some mathematics at this level but this data is not available nationally. The number of students entered for this qualification is relatively small - 5,584 students, of whom 3,994 (71.53%) pass.[2]

No data on students in vocational education taking mathematics was available.

4. What is the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

Of the three main mathematics subjects, mathematics in Science Technology focuses on pure mathematics to prepare students for university degrees that include mathematics and science. Social Sciences and the Health Sciences contain applied mathematics content.

Mathematics in Science and Technology includes: number and algebra; geometry; calculus; and statistics. It requires the use of mathematical concepts and mathematical reasoning, with the aim of developing reasoning and problem-solving skills for students wishing to study science and technical subjects at university.

1 All data: http://www.ine.es/jaxi/tabla.do?path=/t13/p411/2009/l0/&file=03002.px&type=pcaxis&L=0

2 All data: http://www.ine.es/jaxi/tabla.do?path=/t13/p411/2009/l0/&file=03002.px&type=pcaxis&L=0

Mathematics in Social Sciences and Health Sciences includes: number and algebra; calculus; and statistics. The objective is for students to recognize the role of mathematics in understanding social and economic issues in everyday life.

5. What drives the pattern of take-up? How is it linked to the needs of HE, employers and national policy objectives?

A number of career paths or degree programmes such as mathematics or engineering require applicants to have studied mathematics at upper secondary level.

Students have to pass PAU based on the component subjects of their *Bachillerato* if they want to study a university degree. The PAU represents 40% of the total qualification that is taken into account for university entrance. The other 60% corresponds to the qualifications gained in secondary and upper secondary. Students' choice of university depends on these results. The PAU system due to change in 2010.

6. How is the picture changing over time?

A new PAU university entrance exam will be introduced in 2010. Students will be examined in the common subjects of all the pathways (including Spanish language, history of philosophy and a foreign language, but *not* mathematics), and one or more subjects selected from those they have studied.

Sweden

1. What is the national policy for, and structure of, mathematics education provision for 16-18/19 year-old (pre-university level) learners?

Education in Sweden from 16-19 is non-compulsory and lasts for three years. Admission is granted through a compulsory school-leaving certificate with passing grades in Swedish or Swedish as a second language, English and Mathematics. Pupils who do not have this may follow an individual programme.

Upper secondary school education is organised in 17 different national programmes, all of which are designed around the same eight core subjects: Swedish, or Swedish as a second language; English; mathematics; civics; religion; science studies; physical education and health; and artistic activities. In addition to these core subjects, pupils study subjects specific to their chosen programme.

All students take a mandatory 100 credits of mathematics, out of a total 2,500 credits to be completed. Further credits may be taken dependent on the chosen programme.[1]

The upper secondary school does not have a final examination. Each pupil receives a school-leaving certificate consisting of a summary of the courses in the pupil's study plan and the grades received in these courses.

2. What are the overall participation rates in mathematics study for 16-18 year-olds both as proportions of students and proportions of the age cohort?

Statistics of the participation rates in the national and individual programmes are available, but no data is available on participation in the mathematics components of these programmes.[2]

3. What are the patterns of participation in terms of following different routes involving mathematics?

Vocational and general upper secondary education is provided within the same institutions run by municipalities, county councils or independent organisers. Schools have different profiles and run different national programmes. Of the students in national programmes, 47% participate in vocational education and 53% attend general programmes.[3]

1 For more detail on the content of individual programmes see http://www3.skolverket.se/ki03/front.aspx?sprak=EN&ar=0910&infotyp=15&skolform=21&id=52

2 http://www3.skolverket.se/ki03/front.aspx?sprak=EN&ar=0910&infotyp=15&skolform=21&id=52

3 http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/eurybase_full_reports/SE_EN.pdf p.84

4. What is the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

Mathematics is comprised of five cumulative courses *(Mathematics A-E),* and two other courses *(Mathematics - discrete* and *Mathematics - extension)*.. *Mathematics A* is a core subject course and is included in all programmes.

The courses builds on the mathematics studied in compulsory schooling, providing broader and more advanced knowledge in the areas of arithmetic, algebra, geometry, statistics and the theory of functions. The courses are studied by pupils with widely different study orientations. The structure is modified and the problems chosen are based on the pupils' study orientation. The courses provide general civic competence and constitutes an integral part of the chosen study orientation.[4]

The remaining courses may or may not be taken depending on the programme chosen.

5. What drives the pattern of take-up? How is it linked to the needs of HE, employers and national policy objectives?

The report *Enhancing the status of mathematics* (*Att lyfta matematiken – intresse, lärande, kompetens*, SOU 2004:97) has led to support for developing mathematics locally in each municipality. The work of developing mathematics is co-ordinated by the Swedish National Agency for School Improvement (*Myndigheten för skolutveckling*, MSU). The revised support material is related to reality, to simulate problem-oriented and communicative processes in mathematics. It can be used directly in teaching.

Co-operation between upper secondary schools, technical universities, and university colleges should aim to develop working methods which better prepare pupils for higher education.

6. How is the picture changing over time?

Within the next couple of years, mathematics courses will be adjusted within the different national programmes.

4 http://www3.skolverket.se/ki03/front.aspx?sprak=EN&ar=0910&infotyp=8&skolform=21&id=MA

Taiwan

1. What is the national policy for, and structure of, mathematics education provision for 16-18/19 year-old (pre-university level) learners?

Education is non-compulsory from 16-19 in Taiwan. Students typically graduate from Junior High School at about 15 years old and then enter a three-year programme in a Senior High School or a Senior Vocational School. Some students may choose Five-Year Junior College.[1]

The curriculum structure of mathematics education in Taiwan is divided into 2 major categories. One category is for senior high school students or students who study in vocational school but want to pursue academic research in the future. In the 1st and 2nd year, these students study Basic Mathematics which is compulsory. In the 3rd year, students study Mathematics I and may choose Mathematics II depending on their interests.[2] The other category is for senior vocational school students, and has four types of mathematics courses to fit different needs. The vocational mathematics curriculum can also be chosen in the first three years in Five-Year Junior College.[3] The mathematics courses available are shown in the table below.

SCHOOL	COURSE	DETAIL
Senior High School	Basic Mathematics	All students must take Basic Mathematics in the 1st and 2nd year.
	Senior Vocational School	For all students. This is a full-year course for students who intend to enter programmes of Social Sciences, Humanity, Law, Education and Arts at university, and a one-semester course for students who intend to enter programmes of Natural Sciences, Engineering and Medicine at university.
	Mathematics II	This is studied in the last semester for students who intend to enter programmes of Natural Sciences, Engineering and Medicine at university.
Senior Vocational School	Mathematics A (8 hours/ 3 years)	For students who study Home Economics.
	Mathematics B (12 hours/ 3 years)	For students who study Commerce and Management, Agriculture and Food Science, Marine Technology and Fishery, Hospitality, Design, and Foreign Language.
	Mathematics C (16 hours/ 3 years)	For students who study Engineering and Architecture.
	Mathematics S (4-6 hours/ 3 years)	For students who study Art.

1 http://english.moe.gov.tw/ct.asp?xItem=4133&CtNode=2003&mp=1

2 http://www.edu.tw/high-school/content.aspx?site_content_sn=8411

3 http://vtedu.ntust.edu.tw/front/bin/ptlist.phtml?Category=7

2. What are the overall participation rates in mathematics study for 16-18 year-olds both as proportions of students and proportions of the age cohort?

In 2009, the number of 15-17 year olds in Taiwan was approximately 967,141.[4] Of the age cohort, 92% were in upper secondary education (about 38% in senior high school and about 54% in the vocational school system, including the first three years of the Five-Year Junior College).[5]

The table below shows the number of mathematics entries for each category and version studied in 2009/2010. It also shows these entries as percentages of the total student cohort and the total age cohort.

SCHOOL AND COURSE		TOTAL ENTRIES[6] (1)	APPROXIMATE SIZE OF AGE 15-17 COHORT[7] (2)	APPROXIMATE SIZE OF COHORT IN EDUCATION[8] (3)	TOTAL ENTRIES AS PERCENTAGE OF AGE COHORT [=(1)/(2)]	TOTAL ENTRIES AS PERCENTAGE OF COHORT IN EDUCATION [=(1)/(3)]
Senior High School[9]			967,141	893,182	37.6%	40.7%
Senior Vocational School	Mathematics A	41,478			4.3%	4.6%
	Mathematics B	270,512			28.0%	30.3%
	Mathematics C	160,933			16.6%	18.0%
	Mathematics S	6,243			0.6%	0.7%
Five-Year Junior College (the first three years only)[10]	Mathematics A	26,610			2.8%	3.0%
	Mathematics B	14,164			1.5%	1.6%
	Mathematics C	4,557			0.5%	0.5%
	Mathematics S	1,138			0.1%	0.1%

3. What are the patterns of participation in terms of following different routes involving mathematics?

Mathematics is a compulsory subject for all students whether they study in senior high schools or in senior vocational schools. Students must take the related mathematics route for the

4 http://www.edu.tw/statistics/content.aspx?site_content_sn=8869, table 28.

5 http://english.moe.gov.tw/public/Attachment/04201511971.xls

6 http://www.edu.tw/statistics/publication_list.aspx, 高級中等學校概況統計(98學年度).

7 http://www.edu.tw/statistics/content.aspx?site_content_sn=8869, table 28.

8 http://www.edu.tw/statistics/content.aspx?site_content_sn=8869, table 27, age 15~17, number of students in senior high and vocational groups.

9 Proprtion who go on to study Natural Sciences, Engineering and Medicine at university was 47% in 2009/10: http://english.moe.gov.tw/public/Data/052817225871.xls

10 http://www.edu.tw/statistics/content.aspx?site_content_sn= 21549, 大專校院各校科系別學生數.

programme they study in order to gain the senior high school or senior vocational school qualification. [11]

4. What is the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

The mathematics provided to Senior High School students emphasises pure mathematics with fundamental probability and statistics, and is geared for study in university. Basic Mathematics is studied by the 1st and 2nd year students while Mathematics I and II are advanced and studied by the 3rd year students. Mathematics I is about advanced statistics, matrix, and inequality. Mathematics II is about calculus. Mathematics II is especially for equipping those students who would like to enter Science, Engineering and Medicine programmes at university.[12]

In comparison with Senior High School Mathematics, the mathematics for Senior Vocational School is more real-life mathematical skills oriented. Each course has been designed with a different focus and weight to fit the vocational needs and the programme arrangement.13 Mathematics S and A are the lowest two levels. They share the same topics including linear equations, functions, vectors, inequality, progression and series, probability, and statistics. However, Mathematics A is deeper than Mathematics S. As well as the fundamental topics in Mathematics S and A, Mathematics B has conic section and calculus. Mathematics C is the highest level and has the content of Mathematics B besides the topic of complex number.

5. What drives the pattern of take-up? How is it linked to the needs of HE, employers and national policy objectives?

Since courses of mathematics are compulsory for all programmes and the curricula have been developed to fit the needs of students for coping with different vocations or future studies, students have no choice but to follow the relevant mathematics curriculum.[14] Moreover, for those students who want to enter universities, Basic Mathematics, Mathematics I, and Mathematics II are a necessity for passing the university entrance examination.

6. How is the picture changing over time?

The Ministry of Education has plans to make upper secondary compulsory.[15] This is still being debated, but mathematics education would change dramatically if the length of compulsory education were to be extended to 12 years.

11 http://www.edu.tw/high-school/content.aspx?site_content_sn=8411 and http://vtedu.ntust.edu.tw/front/bin/ptlist.phtml?Category=7

12 http://www.edu.tw/high-school/content.aspx?site_content_sn=8411

13 http://vtedu.ntust.edu.tw/front/bin/ptlist.phtml?Category=7

14 http://www.edu.tw/high-school/content.aspx?site_content_sn=8411 and http://vtedu.ntust.edu.tw/front/bin/ptlist.phtml?Category=7

15 http://english.moe.gov.tw/ct.asp?xItem=11701&ctNode=814&mp=1

USA – Massachusetts

1. What is the national policy for, and structure of, mathematics education provision from 16-18/19 year old (pre-university level) learners?

USA

The USA is a federation of states each of which has considerable autonomy. Education structure is determined at both the state and local levels. Education is compulsory in all states, usually from the age of around 6 to 16. The final years of education necessary for graduation are provided in high school, usually including Grades 10-12 (students aged 15 to 18), or Grades 9-12 (students aged 14 to 18). All of these Grades are not usually compulsory.

There are national tests. Participation is voluntary and the types of test available include Scholastic Aptitude Tests (SATs), American College Testing (ACT) and Advanced Placement (AP) examinations, which all assess students' suitability for admission to higher education.

The Scholastic Achievement Test (SAT):

- The *SAT I* is primarily a multiple-choice test that measures verbal and mathematical reasoning abilities. The test is divided into seven half-hour sections: three verbal; three mathematical; and one additional section, which is either verbal or mathematical. This last section is intended to ensure the same level of difficulty from year to year and does not count towards a student's final score.
- The SAT II, which measures subject knowledge in a specific subject area, is also primarily multiple choice, but only lasts one hour. There are varied subjects to choose from, mathematics included.

If students complete their education (Grade 12 – age 18) they receive their High School Diploma. High School Diplomas represent a variety of different curricula and standards.

Massachusetts

Curriculum guidelines in Massachusetts give seven discipline areas:

- mathematics;
- science and technology;
- social science/social studies (includes US and world history, geography, economics, civics and government);
- English language arts;
- world languages;
- the arts (includes dance, music, theatre and the visual arts); and
- health (includes health education, physical education and family and consumer science education).

Mathematics is followed by all students who pursue the Massachusetts Comprehensive Assessment System (MCAS) leading to the Massachusetts version of a high school diploma.[1]

2. What are the overall participation rates in mathematics study for 16 – 18 year olds both as proportions of students and proportions of the age cohort?

The profile of students (all USA) taking mathematics courses in High School in 2005 was as follows[2].

MATHEMATICS COURSE	PERCENTAGE
Any mathematics course	100
Algebra I	63
Geometry	83
Algebra II	70
Trigonometry	8
Analysis/pre-calculus	29
Statistics/probability	7
Calculus	14
AP calculus	9

The proportion of students in high school in Massachusetts is high and few students follow a vocational route.[3]

3. What are the patterns of participation in terms of following different routes involving mathematics?

The Director of Statewide Mathematics Initiatives, from the Department of Elementary and Secondary Education, confirms that no information is currently available to answer this question.

4. What is the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

The Massachusetts mathematics curriculum was written in 2000 and spans pre-kindergarten to grade 12.

The areas of the curriculum are Algebra I, Geometry, Algebra II, and Pre-calculus. These are each comprised of strands with specific learning standards. The strands are: number sense and

1 http://www.inca.org.uk/usa.html

2 http://nces.ed.gov/programs/digest/d09/tables/dt09_151.asp

3 http://www.doe.mass.edu/infoservices/reports/

operations; patterns, relations and algebra; geometry; measurement; data analysis, statistics and probability. Overarching and running through all these strands and courses are key competencies: problem solving; communicating; reasoning and proof; making connections; and representations.

1. Number sense and operations

Learning what numbers mean, how they may be represented, relationships among them, and computations with them.

2. Patterns, relations and algebra

Understand how patterns, relations, and functions are interrelated; be able to represent and analyze mathematical situations and structures using algebraic symbols; use mathematical models to understand quantitative relationships; and analyze change in various contexts.

3. Geometry

Understand the structure of space and the spatial relations around them, measure many aspects of their environment, and communicate this structure, these relations, and their measurements to others.

4. Measurement

Length, perimeter, area, volume, and angle measure, temperature and mass, density.

5. Data analysis, statistics and probability

Learn to collect, organize, and display relevant data to answer questions that can be addressed with data; use appropriate statistical methods and predictions that are based on data; develop and evaluate inferences and predictions that are based on data; and apply basic concepts of probability.

The learning standards specify what students should know and be able to do as learners of mathematics at the end of each grade. The Learning Standards for Grades 11–12 are:

1. Number Sense and Operations

- Investigate special topics in number theory, e.g., the use of prime numbers in cryptography.
- Use polar-coordinate representations of complex numbers (i.e., $a + bi = r(\cos\theta + i\sin\theta)$) and DeMoivre's theorem to multiply, take roots, and raise numbers to a power.
- Plot complex numbers using both rectangular and polar coordinate systems.

2. Patterns, Relations, and Algebra

- Prove theorems using mathematical induction.

- Investigate parametrically defined curves and recursively defined functions, including applications to dynamic systems.

3. Geometry

- Investigate and compare the axiomatic structures of Euclidean and non-Euclidean geometries.
- Explore the use of conic sections in engineering, design, and other applications.
- Investigate the notion of a fractal.
- Use graphs (networks) to investigate probabilistic processes and optimization problems.

4. Data Analysis, Statistics, and Probability

- Use technology to perform linear, quadratic, and exponential regression on a set of data.
- Design surveys and apply random sampling techniques to avoid bias in the data collection.[4]

5. What drives the pattern of take-up? How is it linked to the needs of HE, employers and national policy objectives?

The High School Diploma grants access to higher education and has currency in the workplace.

6. How is the picture changing over time?

Figures for Massachusetts show that the number of student passing the Massachusetts Comprehensive Assessment System (MCAS) mathematics component in Grade 10 has risen steadily.[5]

YEAR	PERCENTAGE PROFICIENT	PERCENTAGE PASSING
2001	45	75
2005	61	85
2009	75	92

USA statistics show:

- Enrolment (USA) in grades 9-12 from 1985 to 2009 has increased by 20%. Projections of secondary enrolment - expected to decrease between 2009 and 2011, and then start to increase again in 2012.
- The average number of science and mathematics credits earned by high school graduates increased between 1982 and 2005. The mean number of mathematics credits (Carnegie units[6]) earned in high school rose from 2.6 in 1982 to 3.7 in 2005.[7]

4 http://www.doe.mass.edu/frameworks/current.html

5 http://www.doe.mass.edu/candi/summit/MA2009_StateofEducation.pdf

6 The Carnegie unit is a standard of measurement that represents one credit for the completion of a 1-year course.

7 http://nces.ed.gov/pubs2010/2010014.pdf and http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2010013

Wales

1. What is the national policy for, and structure of, mathematics education provision for 16-18/19 year-old (pre-university level) learners?

From the age of 16, education is non-compulsory in Wales. Students must apply for admission to specific programmes at this level. A majority of students taking ISCED level 3 qualifications across all subjects take A-levels, made up of two courses lasting one year each – AS and A2. At the end of the first (AS) year students can choose to take the AS level as a standalone qualification or continue their study to achieve a full A-level. A-levels are the most widely recognised qualification for university admission.

Schools and colleges set their own admissions criteria, but commonly ask for a minimum of five GCSE[1] passes at grades A*, A, B or C for admission to A-level courses. These often include the achievement of GCSE passes at specified grades in the subjects to be studied at A-level.

AS/A-level and several other types of qualifications offer mathematics at this level.

QUALIFICATION	DETAILS
A-level / AS-Level	– Mathematics – Further Mathematics – Statistics – Use of Mathematics (currently being piloted)
Free Standing Mathematics Qualification (Advanced)	Students can take four Advanced FSMQs (each roughly equivalent to one third of an AS-level). The qualifications also provide UCAS points which are used for university admission.
Essential Skills	– Application of Number This will replace the existing Key Skills Application of Number and Basic Skills Adult Numeracy qualifications when the Essential Skills Wales qualifications are launched in September 2010.
Welsh Baccalaureate Qualification (Advanced)[2]	The WBQ combines personal development skills with existing qualifications like A-levels, NVQs and GCSEs to make one wider award. There is a mandatory 'Key Skills' component of which 'Application of Number' is one part.

A number of vocational qualifications are also available, which cannot be taken as standalone mathematics qualifications at this level, but may feature elements of mathematics depending on the chosen course. These include National Vocational Qualifications (split into five levels, with the third level comparable to A-levels) or the BTEC Diploma (equivalent to three A-levels).

1 The General Certificate of Secondary Education, usually taken at the end of lower secondary education.

2 http://www.wbq.org.uk/

2. What are the overall participation rates in mathematics study for 16-18 year-olds both as proportions of students and proportions of the age cohort?

The table below[3] shows the numbers of learning activities for each of the main qualifications that incorporate mathematics at ISCED level 3.

<table>
<tr><th>QUALIFICATION</th><th>FE INSTITUTIONS, COMMUNITY LEARNING AND WORK BASED LEARNING PROVIDERS</th><th>SCHOOL SIXTH FORMS</th><th>TOTAL LEARNING ACTIVITIES</th><th>APPROX. SIZE OF AGE COHORT[4]</th><th>ESTIMATED SIZE OF COHORT IN EDUCATION OR TRAINING[5]</th></tr>
<tr><td>AS level Mathematics</td><td>1,510</td><td>4,465</td><td>5,975</td><td rowspan="2">40,100</td><td rowspan="2">30,490</td></tr>
<tr><td>AS level Further Mathematics</td><td>70</td><td>230</td><td>300</td></tr>
<tr><td>A level Mathematics</td><td>700</td><td>2,435</td><td>3,135</td><td rowspan="3">41,000</td><td rowspan="3">23,160</td></tr>
<tr><td>A level Further Mathematics</td><td>100</td><td>140</td><td>240</td></tr>
<tr><td>International Baccalaureate</td><td>90</td><td>25</td><td>115</td></tr>
<tr><td>Key Skill - Application of Number (level 3)</td><td>1,780</td><td>5,560</td><td>7,340</td><td>-</td><td>-</td></tr>
<tr><td>Key Skill - Application of Number (all levels)</td><td>20,375</td><td>14,075</td><td>34,450</td><td>-</td><td>-</td></tr>
</table>

The official (JCQ) 2009 report on A-level results in the UK indicates that of all A-level examinations sat in Wales that year, 8% were in Mathematics and 0.5% were in Further Mathematics (these data incorporate AS and A2 results).[6] This is a more robust comparison of total participation (albeit only for A-levels) and A-level mathematics but underestimates the actual proportion of students studying mathematics, as students generally take more than one (usually three) A-levels. If we crudely assume the number of A-levels students take averages to three, then 24% of A-level students took Mathematics (AS or full A-level).

3 Data provided by Welsh Assembly Government (DCELLS). Collated from Post-16 Pupil Level Annual Schools Census (PLASC), Lifelong Learning Wales Record (LLWR), Higher Education Statistics Agency (HESA) and Office for National Statistics end of year population estimates.

4 Estimates of 17 and 18 year olds in base population (figures (1) and (2) respectively) taken from "Participation of Young People in Education and the Labour Market, 2007" release.

5 Overall numbers of 17 and 18 year olds in education or training (figures (3) and (4) respectively) taken from "Participation of Young People in Education and the Labour Market, 2007" release.

6 http://www.jcq.org.uk/attachments/published/984/JCQ GCE Results 2009.pdf

QUALIFICATION	TOTAL ENTRIES[7]
AS-Level Mathematics	4,069
AS-Level Further Maths	245
A-Level Mathematics	3,165
A-Level Further Maths	250

3. What are the patterns of participation in terms of following different routes involving mathematics?[7]

The majority of A/AS/A2 levels are undertaken at secondary school sixth forms. Estimated data relating to take-up in schools is not available at the time of writing.

Of the 1,454 level 3 qualifications in Mathematics attained at Welsh further education institutions in 2008/09, 98.8% were A/AS/A2 levels and 1.1% were National/First Certificates/ Diplomas. This excludes Key Skills in Application of Number at level 3.

4. What is the content and level of the different kinds of provision? In particular, what might be deemed general mathematics and what aligned to specific pathways?

Of the three main mathematics qualification routes, AS/A-levels focus on pure mathematics, with applied options in mechanics and statistics or decision. They are at an advanced level and geared towards complex technical use of mathematics for study in higher education.

Free-Standing Mathematics Qualifications follow the general topics of the A level but focus on a smaller number of them in detail. They can be useful for: enhancing and supporting knowledge in other areas; developing specific knowledge and skills beyond GCSE, without having to follow an academic mathematics course; or developing real-life mathematical skills.

The Essential Skills qualifications are offered at ISCED level 3. They cater to everyday uses of mathematics. More detailed information on their content is currently unavailable pending their launch in September 2010[8].

5. What drives the pattern of take-up? How is it linked to the needs of HE, employers and national policy objectives?

Although students will usually need to satisfy the entry requirements of the school or college, student take-up of post-16 mathematics is largely self-selecting. In some cases, students will pursue mathematics for their own interest without specific career or educational goals in mind, or will choose not to study mathematics because they perceive it to be a difficult subject. In other cases, take-up will be driven by career or educational goals. For example, while a number of career paths or degree programmes such as mathematics or engineering may require

7 http://www.jcq.org.uk/attachments/published/984/JCQ GCE Results 2009.pdf

8 http://essentialskillswales.co.uk/essential-skills/application-number-introduction/

applicants to have an A-level in mathematics, this is viewed as beneficial but not mandatory for many other courses, such as computer science or physics. For related degree programmes with a high level of competition for places, a mathematics qualification may confer an advantage over other qualifications.

How is the picture changing over time?

The education of 14- to 19-year-olds is currently an area of reform in Wales. The Learning and Skills (Wales) Measure, passed in March 2009, will create a right for 14- to 19-year olds to follow a course of study from a local area curriculum or 'Options Menu', which will contain a wide range of academic and vocational study options.

No clear trend has emerged in the percentage of students taking Mathematics at A-level in secondary schools in Wales, though the percentage taking Further Mathematics has shown a small increase since 2000.

A level entries for Mathematics and Further Mathematics, students of any age, secondary schools

ACADEMIC YEAR	TOTAL A LEVEL ENTRIES				
	FURTHER MATHEMATICS		MATHEMATICS		ALL SUBJECTS
	NUMBER	PER CENT	NUMBER	PER CENT	NUMBER
2008/09	184	0.6	2,563	8.4	30,385
2007/08	142	0.5	2,436	8.3	29,385
2006/07	140	0.5	2,226	7.8	28,491
2005/06	137	0.5	2,047	7.1	28,669
2004/05	148	0.5	2,107	7.6	27,894
2003/04	105	0.4	1,952	7.2	27,016
2002/03	113	0.4	1,930	7.3	26,457
2001/02	101	0.4	1,771	6.9	25,715
2000/01	45	0.2	2,238	8.9	25,159
1999/2000	36	0.1	2,173	8.5	25,687
1998/99	43	0.2	2,308	9.1	25,351
1997/98	36	0.1	2,327	9.1	25,699
1996/97	46	0.2	2,260	9.5	23,846
1995/96	54	0.2	2,169	9.5	22,944

9 Excludes Vocational Double Award A levels.

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