



International Commission on Mathematical Instruction

# **Pipeline Project**

# **Pilot Final Report**



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## The Pipeline Project Pilot Final Report

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The aim of the Pipeline Project has been to collect, on an international basis, data about the number of mathematical science students passing through four transition points:

- 1. school to undergraduate courses;
- 2. undergraduate courses to postgraduate courses;
- 3. university into employment;
- 4. university into teaching.

After distributing an initial questionnaire to establish availability of data, the Pipeline project was restricted to a Pilot Case Study format, and began collecting data from ten countries: Australia, Finland, France, Hong Kong, New Zealand, Portugal, Taiwan, UK (as well as more detailed information from each of England & Wales and Scotland), and USA. There were great fluctuations between countries as to what data was available.

Overall, the perception that there are globally declining numbers of students seems to be unfounded. There are many fluctuations within the data for each country but general findings for each transition point are:

1	The number of school leavers with mathematical science is increasing although Australia and France are exceptions to this.
2	The number of bachelor graduates is increasing although the numbers in the USA are currently decreasing. Generally there is an overall increase in the numbers of Masters graduates, with Australia again an exception. For all the countries for which we have data, there is an increase in the number of mathematical science PhD graduates.
3	There are small increases in the number of mathematical science bachelor graduates who are in full-time employment six months after graduation. There are corresponding small decreases in the number of students entering further full-time study.
	The data for which industry mathematical science graduates are entering is very complex. It is difficult to make any judgments on this.
4	The number of mathematical science graduates entering teaching is generally decreasing.

Despite considerable effort, data collection and analysis proved to be even more difficult than initially anticipated. The data was difficult to obtain, was inconsistent, was patchy, and was badly defined. The project did not attract funds for dedicated researchers (except in NZ), although it is unclear that further resources would have produced a significant improvement in the data.

Many of the fluctuations in the data are for unknown reasons. However there are some fluctuations that appear to be attributed to curriculum changes, governmental policy, and financial climate.

Although the number of qualified mathematical science graduates from school and university is generally increasing, the number of mathematical science bachelor graduates as a proportion of total bachelor graduates seems to be gradually decreasing for the four countries for which we have data (NZ, Taiwan, UK and USA). Also, although more mathematical science graduates are entering employment after graduation, they are not entering full-time study in the numbers they have previously. In particular, graduates are entering teaching in lower numbers.

The Pipeline Pilot Project concludes that, in general, school leavers are being drawn into an increasing number of alternative choices of degree subjects, some containing some mathematical components (for example, finance). The result is an overall decrease in broadly qualified undergraduates in the mathematical sciences. This in turn produces a shortfall of graduates entering the workforce who are broadly qualified in mathematical sciences.

The Pipeline Pilot Project recommends:

- 1. That member countries of IMU and ICMI be urged to establish a process where national data on the mathematical science pipeline can be systematically gathered for future policy development.
- 2. That ICMI maintains a website to collect data globally, and add future data as supplied by the different countries. This website should develop a range of definitions so that data can be compared and amalgamated internationally.
- **3.** That IMU and ICMI consider a follow-up project that attempts gauge the mathematical strength of a Bachelor degree in mathematical science over time.

## Introduction

The Pipeline Project was initiated to investigate the movement of mathematical science students worldwide as they moved through universities into employment.

Originating with IMU, and given to ICMI to implement, the Project took some time to get established, and then ran into data comparison difficulties, both between countries, but also between different time periods within countries.

The Project changed into a pilot mode with case studies of a number of countries where data was available and people volunteered to gather and analyse it. This report is the culmination of that phase.

Throughout this report we use the terms "mathematical sciences", "mathematics" and "mathematically". The meaning of these words represents courses in degrees in Pure and Applied Mathematics, Statistics, Engineering Science, Operations Research, Logic and Computation, and other subjects that contain a significant amount of Mathematics. Where we wish to refer to the subject of (Pure and Applied) Mathematics itself (i.e. not including Statistics, etc), then we capitalise Mathematics. It was decided not to include Computer Science in this definition, despite the acknowledgement that Computer Science courses often contain significant mathematical components.

## **Project Development**

The Pipeline project was conceived with the IMU Executive in 2006, who requested ICMI to make an investigation into the flows of mathematically educated students through universities on a worldwide basis. It was motivated by a perceived decline in both the numbers of students choosing to pursue mathematical study, and a lack of suitably qualified people choosing to become mathematics teachers.

The ICMI Executive appointed an initial Oversight Committee consisting of Frederick Leung (HK, Chair), Hyman Bass (USA), Michèle Artigue (France), and Victor Vassiliev (Russia). American Mathematical Society representatives consulted in the early phase were John Ewing, Jim Maxwell, Bernie Madison and Jim Lewis.

In April 2007, a meeting at the American Mathematical Society considered how to pursue the project, and drafted a Map of Existing Terrain. The ICMI Executive appointed Frederick Leung to direct the project, and he reported at its June meeting that year.

It was already known by the beginning of 2008 that data collection was a much more difficult task than had been anticipated. A "Survey Team" had been appointed for the July 2008 Monterrey ICME with the title "Recruitment, entrance and retention of students to university mathematics studies in different countries". Chaired by Derek Holton, the members of this team attempted to collect relevant data and had some difficulty even collecting data from their own countries.

Further evidence of difficulties came from a survey sent out by Frederick Leung in 2007 to those willing to respond on whether data was available, and how difficult it was to obtain. Responses were obtained from Australia, France, Finland, NZ, Portugal, and USA.

A meeting of a project team (Frederick Leung, Hyman Bass, Michèle Artigue, along with Bill Barton (NZ), Jaime Carvalho (Portugal), and Derek Holton (NZ)) in Rome in March 2008 considered Frederick Leung's Survey results and agreed that a Case Study approach was the only one feasible. That meeting produced a document extending the one produced at the AMS meeting the previous year. The team decided to develop a Moodle site, and to focus work around four transition points using data from eight pilot countries. It was agreed to support the work of Derek Holton's Survey team until the Monterrey conference, and then develop a Pilot Phase of eight countries through 2008/2009. A final report on the Pilot Phase was scheduled for the end of 2009.

The Survey Team not only reported at Monterrey in July, but most of its findings were collected together into a Special Issue of *International Journal of Mathematical Education in Science and Technology 40*(1), published in January, 2009.

Each of the participating pilot countries was requested to find people who would be able to work on the project. While several interested contacts were established, it was only in August, 2008, that any dedicated person became available. Louise Sheryn, a post-doctoral researcher at The University of Auckland was employed half time to work on the New Zealand Pipeline data. (We are grateful to the New Zealand Institute of Mathematics & Its Applications (NZIMA) for funding a major programme that included the NZ researcher into Pipeline data). No other countries managed to find or fund a Pipeline Researcher. Although no funded researchers were available, we are indebted to mathematics educators and others who freely gave their spare time to help with the project. Their efforts are highly appreciated, but the task was too big.

As a result, the directorship of the project shifted to New Zealand, where first Derek Holton, and then, on Derek's retirement, Bill Barton agreed to direct the project to the end of its Pilot Phase. Louise Sheryn focussed first on NZ data, but, in December 2008, turned her attention to managing the whole project through the Moodle site. During 2009, the eight countries became ten (including not all the initial eight) because of the availability/unavailability of data and informants. The final countries represented in this report and people who made significant contributions to the data collection are:

Australia	Peter Johnston and Frank Barrington
Finland	Juha Oikkonen and Terhi Tuulia Hautala
France	Michele Artigue and Pierre Arnoux
Hong Kong	Frederick Leung
New Zealand	Louise Sheryn and Bill Barton
Portugal	Jaime Carvalho E Silva
Scotland	Norman Reid
Taiwan	Fou-Lai Lin
United Kingdom	Celia Hoyles
United States of America	Jim Maxwell and Bernie Madison

An interim report was prepared for the IMU Executive Meeting in April, 2009. A presentation on the project was made by Louise Sheryn and Bill Barton at the "Paradigms in Mathematical Education for the 21<sup>st</sup> Century" conference in Valencia, Spain, in October, 2009.

### **Data Analysis**

From the beginning of the project, the data gathering and data analysis quickly emerged as a significant problem. Indeed, these difficulties were primarily responsible for the delays in the project, and the decision to reduce it to a Case Study format.

In order to draw any serious conclusions, it is necessary that we access time-series data for a significant length of time. We hoped for data from the 1960s, but except in some rare cases, such data did not appear to be available.

We also needed data at different stages of the Pipeline. While some graduate information was relatively easy to obtain, we were not successful in obtaining very much data on the numbers of school graduates in the mathematical sciences, and the flow into the workforce.

But the biggest problem of all was consistency of the data. First of all, the names of degrees and school mathematics courses changed over time in all countries in the study. Even when the name remained the same, the content and scope of the courses changed regularly—school curricula change about every ten years on average. In the school situation, in addition to divergent types of schools and courses at the senior secondary level, the assessment and qualification systems also

changed several times in the period of the study in most countries. At university level, there were changes in the name, type and length of degree courses.

Hence obtaining the data was a task of complexity well beyond that anticipated. Even within a single country the problem was virtually insurmountable. Many individual reports existed, but these were either inconsistent (different numbers although they appeared to be counting the same thing), or incomplete (short time-series only), or non-comparable (different bases for the numbers—for example Mathematics could refer to just the subject Mathematics or all the mathematical sciences, and the latter had several different interpretations).

For example, one person working half time for one year on the NZ Pipeline project was unable to get complete data for this small (4.5 million population, 8 university, country). University data is not held in any useful form nationally, so individual universities needed to be approached, privacy legislation had to be negotiated, old data was either missing or did not exist in electronic databases, and local knowledge had to be sought for the meanings of categories.

Another more subtle source of difficulty was the preconceptions of the informants. In this project we wished to rely on data evidence only, but the temptation to leap to conclusions on incomplete data (even amongst the team members) was very strong. The problem existed more clearly in reports that had been prepared with particular agendas in mind, and in the willingness of some people to offer information, which turned out to be opinion and not data.

Generally every organisation approached has been very cooperative as far as their records allow. Some paper-copy records have still yet to be investigated. Difficulties accessing this information arise from the location and cost of retrieving the data. We assess as unlikely the accessing of significant further data without a prohibitive investment in employment of researchers.

The data came from a variety of sources:

- online spreadsheets and databases, predominantly from the Education Ministries from the project countries or Government Statistics departments;
- organisations providing access to annual reports;
- organisations & individuals supplying raw data.

We acknowledge that the fullest data sets have generally come from English-speaking countries. This is probably a result of the main researcher being an English speaker.

A summary of data can be found in Appendix A.

## **Case Study Analysis for Each Country**

Within this section we outline the general findings for each country. We have selected at least one significant graph for each country.

#### a. Australia

The percentage of school leavers who are studying mathematics at intermediate or higher level has been decreasing over the last 12 years. These are the levels of qualification that will allow students to study sciences or mathematical sciences at university. However, the number of students studying Elementary mathematics (non-calculus) is steadily increasing—these students are not prepared for university mathematics courses. On the other hand, the number of graduates at Bachelor Honours level as well as the number of PhD graduates indicates growth since 1959, although different data for 2001-2007 shows the numbers of enrolments into mathematics majors bachelor degrees has decreased. The number of Master graduates has increased from 1959 to 2007, but these numbers are quite low, and there does appear to be a steady decline in numbers from 1979 onwards.

The number of graduates entering either full-time employment or full-time study appears to be consistent over the last 20 years but during 1990-1994 there was a decrease in the percentage of Bachelor graduates entering teaching.



#### b. Finland

The Bachelor and PhD graduate data from Finland indicates a growth in the number of students from 2003 to 2007. Data from the University of Helsinki on Masters Graduates indicates that from 1970 to 2007 there is a decline in the number of students, although there is a gradual recovery in numbers from 1990 onwards.

The Employment Destinations of Bachelor graduates for 2006 indicates that the largest category was for the graduates who entered the teaching profession (49%). The next largest category was Professionals (excluding teaching) at 23%.





#### c. France

In France, there was a steady increase in the number of students taking the mathematics option within Science Baccalaureate program from 1960 to 1994, then there was a substantial drop in the numbers, followed by a continuing, although slower, decrease in numbers until the present. Between 1980-2009 the number of students who went on to study mathematics (and other fundamental science subjects) at scientific university peaked in 1995 and then had slow and steady decline until 2009 when it reached half of the 1995 value. A 2003 reform in the university education system did not affect this decline. The number of Licence and Masters graduates is difficult to assess, due to frequent changes in overall organisation and statistical categories, so no meaningful conclusions can be drawn from available figures. There is a small increase in recent years in the number of PhD graduates, but demographic predictions indicate a drop in the future.

The recruitment of teachers in France from 1960 to 2008 had four phases. During 1960-1975 and 1984-1997 a large number of positions were available, and selectivity was low. During 1976-1983 and after 1997, the number of positions declined very strongly, and recruitment became very selective. Predictions for the coming years are of an even stronger decline in the number of positions, following an official policy of closing half of the positions of retiring teachers. The number of applicants for the teacher hiring examination follows closely the number of positions available with a 4-year lag.

The general pattern of numbers up to 1995 is of a sustained growth, that appears linked to a global increase of the education level of the society. Fluctuations in numbers at all levels seem to be more correlated to political and administrative decisions (reforms, number of teaching positions made available) than to other variables.



#### d. Hong Kong

The pass rates and the number of students entering Advanced Level Mathematics examinations were consistent during 1993-2008. In 1993 the number of students entering Pure Mathematics (5259) & Applied Mathematics (3598) was of similar order. During the next few years the Applied Mathematics numbers decrease and Pure Mathematics numbers correspondingly increase. In 2008 they were: Pure 7848, Applied 1094.

The number of Bachelor graduates increased significantly from 1993-1997, but then decreased until 2002. Since then a recovery in numbers is evident.





#### e. New Zealand

The information on students at Year 13 (the last year of school) is complex, however it indicates a steady increase in student numbers studying mathematics courses from 1960-2007.

A nearly complete dataset for graduates was obtained for The University of Auckland from 1960-2008 and it was found that this data is representative of the general situation of graduates in NZ. There was an increase in the numbers of Bachelor and PhD graduate numbers 1960-2006 although within this timeframe there are some significant fluctuations. The total number of Masters graduates is relatively small but overall there seems to be a decline in numbers with a slight recovery from 1996. In the last decade, the proportional of all Bachelor graduates taking a mathematical science has remained constant at 2%.



From 1991-2007, there is a rise in the percentage of mathematical science students entering fulltime employment. The number of students entering fulltime study seems to be declining at a similar rate. During 1991-1996 there was a significant rise in the number of graduates entering the Business and Financial Services category.

#### f. Portugal

In the last ten years there is a net decrease in the number of mathematical science Bachelor graduates, with a marked increase from 1996-2004 followed by a sharp decrease since then. The number of Master graduates fluctuates markedly over the 12 years but follows a similar pattern. The data for PhD graduates shows an overall growth from 1997-2006 with a decrease in 2007, corresponding to, but not as dramatic as, those for Bachelor and Master graduates.

Anecdotal information from Portugal indicates that the decreases during the last 2 or 3 years are due to announcements from government and unions that there is a surplus of mathematics teachers and that mathematics graduates can go into mathematics teaching only in basic and secondary schools. This trend has affected all classical science graduates and not only mathematics. It is reported that a surplus of teachers that existed in earlier years has disappeared, so from 2009 there is an insufficient number of mathematics and science teachers.





#### g. Scotland

From 1962 to 2009 the numbers entering the school Higher Grade Mathematics examination (for university entry) have risen markedly and the percentage of the cohort has also risen considerably, with some fluctuations.

The numbers entering Higher Education in Mathematics and mathematically based courses has also grown. All school teachers teaching mathematics must be qualified in mathematics and, for many years, there has been no shortage of such teachers.





#### h. Taiwan

Despite some fluctuations there is a small increase in the number of graduates at Bachelor, Masters and PhD levels over the last 17 years. However when this is considered as a percentage of all mathematical science graduates, there is a significant decrease at all levels.





#### i. United Kingdom

The number of students passing Advanced level Mathematics in England and Wales has increased overall from 1960-2007. There have been significant fluctuations in the data during this time – most recently from 2000 when there was a change in the post-16 curriculum. The number of students entering Advanced Level mathematics has recovered since then but the proportion of the 18 year-old population with Advanced Level Mathematics has not.

The number of mathematical science Bachelor graduates in the UK is steadily increasing. The number of mathematical science Bachelor graduates as a percentage of total Bachelor graduates decreased from 4% to just over 2% from 1992 to 1994, however the abrupt nature of this change makes us suspect that a change in definition or data may have occurred. A similar situation exists with PhD graduates from 1995-2007: an increase in numbers but a decrease in the percentage of total PhDs graduates. When the number of Bachelor graduates is compared to the population in England and Wales aged 21, there is a steady increase from 1961-2007. (This is not a direct comparison as the Bachelor graduates data includes Scotland)

Between 1970-2005 the number of Bachelor graduates entering fulltime study drops from 40% down to 25%. The percentage of graduates entering fulltime employment fluctuates considerably, although overall there is a slight decline over this time period. The industry destinations of Bachelor graduates from 1972–1994 indicates that one of the most popular destinations was engineering, although the percentage of graduates entering engineering fell substantially from 1978-1994. The percentage of graduates entering education appeared to be relatively consistent within this timeframe.

From 1997-2008 the number of entries to secondary teacher training rose, with the majority of these being entries into postgraduate teacher training programs. During this same period the number of successful trainee teachers entering a secondary mathematics teaching post fell from 75% to 65%.



#### j. United States of America

Between 1982-2004 there was a significant drop in the percentage of College students with no Mathematics or low academic Mathematics levels. During this period the percentage of students taking Calculus rose from 5.95% of students to 14.1%.

Overall the number of Bachelor, Masters and PhD graduates are generally decreasing from 1966-2006. Also the number of Bachelor and PhD graduates as a percentage of the total number of graduates at that level indicates a decrease. In the last decade, however, the numbers of students graduating at all levels, since 2001, have been increasing.

The data for employment destinations for mathematical science Bachelor graduates was not available, but employment destinations data for students entering science and engineering occupations was considered. From 1991-2002, there is a slight rise in the percentage of students entering these occupations, and at the same time there is a slight increase in the percentage of students entering full-time study.





## **Global Commonalities**

#### a. Transition 1 – School to Undergraduate

*School Leavers:* In Australia and France the number of students studying for senior level mathematics has been declining since 1995. In NZ and the UK the number of students studying/passing Mathematics at Year 13 has been steadily increasing. In Scotland (1962-2009) the percentage of the cohort sitting the Higher Mathematics examination is steadily increasing.

#### b. Transition 2 – Undergraduate to Postgraduate courses

*Bachelor Graduate Numbers*: In Australia, France, Hong Kong, NZ, Portugal, Taiwan and UK there have been some considerable fluctuations in the number of Bachelor graduates, but overall there is an increase. In the USA there has been a decline in the number of Bachelor enrolments/graduates except in the last ten years.



*Masters Graduates:* The trends in Masters graduates vary depending on the country. In Australia there is an overall decline in the number of Masters graduates from 1968-2007. In NZ and the USA although there was a general decline from 1970-1990s, since then there has been a steady increase. There was also an increase in the University of Helsinki Masters graduates from 2000-2007 and in Taiwan from 1991-2007. In Portugal a steady rise from 1995-2006 was followed by a sharp decrease in 2007.

*Doctorate Graduates:* The situation for PhD graduates is similar for Pipeline countries, increasing in Australia, Finland, NZ, Portugal, Taiwan, UK, and USA (with fluctuations). Comparing the number of doctorate graduates in mathematical science as a percentage of all the PhD graduates awarded we have data for Taiwan, UK and the USA where there is a slight decrease from 1995-2007, with a slight recovery for USA in the last couple of years.

#### c. Transition 3 – University to Employment

*Employment Status:* In Australia, NZ, UK and USA, the percentage of Bachelor graduates entering full time employment 6 months after graduation is increasing. The percentage of graduates entering full-time study is increasing in the USA, while it is decreasing in Australia, NZ and UK. All increase and decreases are small.

*Industry Destinations:* We have complex, recent data for the percentage of graduates from Australia, UK and USA and the industry they enter. For Australia, the three most populated categories are Government, Education, and Business and there is a decrease in all three. In NZ there is a sharp increase in Business and Financial Services, a decrease in Wholesale & Retail Trade and no change in Community, Social & Personal Services categories. In UK there is a significant decrease in Engineering, a slight decrease in Education and a moderate increase in Commercial Services.

#### d. Transition 4 – University to Teaching

We managed to obtain data for only three countries: France, NZ and UK. In France the numbers of Secondary Mathematics Teachers recruited has two phases (1960-1975 and 1987-1997) where the numbers of teachers recruited does not meet the number of teaching posts available. The latter phase resulted in a reorganization of the preparation of teachers and since 1998 the full number of posts available have been filled. In NZ there has been a decrease in the percentage of the cohort of trainee teachers who are training to become mathematics teachers. In UK the number of graduates entering initial teacher training has been increasing since 1999. However the percentage of successful trainee mathematics teachers in a teaching post or seeking a teaching post in the first 6 months after completion has decreased during the period 1997-2008.

We also obtained demographic data on the on the mathematics qualifications and age of secondary mathematics teachers from Australia, NZ and England & Wales. While it does not directly fall under the Transition 4 heading of the Pipeline it does provide evidence of the current situation of the teaching profession in these countries.

The situation in each country is not easily compared but there is an indication that there are similarities between the countries. The proportion of mathematically unqualified secondary mathematics teachers in NZ was 25% in 2004 (with the schools in lower socio-economic areas with an average close to 50%). In England & Wales the proportion of teachers without Advanced Level Mathematics rose to 26% in 2007. In 2005 in the Australia, teachers under 30 years were considerably less likely to have a mathematics major or have completed a mathematics teaching methods course than their older colleagues.

In Australia, NZ and England & Wales there are more mathematics teachers approaching retirement than there are teachers under 30 years old. The shortages of mathematically qualified and trained teachers in secondary schools in each of these countries are likely to intensify as current teachers approach retirement age.

## What We Now Know and What We Need to Know

In contrast to the initial perception that there is a decline in the number of mathematical science graduates, it is apparent that the global numbers of graduates at all levels are generally increasing (with a few exceptions at a national level).

It is evident that although numbers are increasing there is an overall decline in the percentage of graduates with mathematical science. This may be attributable to increasing numbers of courses with a mathematical content that are attracting school leavers who would otherwise enrol in a mathematical science undergraduate course.

There are large fluctuations in the data for some countries and for some of these instances we have a degree of understanding of possible reasons. The numbers of students at each of the transition points is sensitive to a variety of factors, for example, curriculum changes, governmental policy decisions, or financial climate. Some specific instances are:

- In England and Wales there was a drop in the numbers of Advanced Level in Mathematics passes in 2001/2 due to the introduction of a new curriculum.
- In Portugal, from 2004, the number of bachelor graduates began a significant decline after a regional director of education stated that there was a surplus of mathematics teachers. This comment was repeated by the Minister of Education.
- NZ, Australia, UK bachelor a common drop in graduate numbers in the early 1970s is possibly due to the introduction of New Math. This is also possibly the case for the PhD graduates in USA.
- The expected influence of the rise of Computer Science, however, does not appear to have affected mathematical science graduates very much at all.

A considerable amount of data collected came from Ministry of Education reports in various countries. It is apparent that the reporting of data for some of these countries goes through various phases and the reporting and focus of certain categories may change from one phase to another. Therefore the data collected may be inconsistent and this may account for some of the greater fluctuations in the data.

It would be beneficial for data in the future to be collected on an on-going basis as and when it becomes available. It is suggested that the data could be collated on a dedicated website and it would enhance the understanding of the situation in each particular country. This website could be managed by ICMI who could make annual requests for data.

The Pipeline Pilot Project recommends:

- 1. That member countries of IMU and ICMI be urged to establish a process where national data on the mathematical science pipeline can be systematically gathered for future policy development.
- 2. That ICMI maintains a website to collect data globally, and add future data as supplied by the different countries. This website should develop a range of definitions so that data can be compared and amalgamated internationally.
- **3.** That IMU and ICMI consider a follow-up project that attempts gauge the mathematical strength of a Bachelor degree in mathematical science over time.

## Appendix A

## Summary of Data

	Transit	tion 1	Transi	tion 2	Transit	tion 3		Transi	tion 4		
	School Leavers	Bachelor Graduates	Masters Graduates	PhD Graduates	Graduate Destinations - General	Graduate Destinations - Employer	Entries to Teacher Training	Recruitment of Teachers	Age of Mathematics Teachers	Tertiary Mx Studies of Mx Teachers	Data Sources
Australia	Y12 Maths Student numbers * 1995-2007	Maths Major enrolments * 2001 2007 Graduates + 1959 2007	Masters Graduates + 1959-2007	PhD Graduates + 1959-2007	Employment Outcomes <sup>⊥</sup> 1989-2008	Grad Dest Employer ⊥ 1990-1994			Age of Secondary Maths Teachers # 2006	Tertiary Studies of Maths Teachers # 2006	* A Nat'l Strategy for Mathematical Science in Australia (2009) + Prof Peter Johnston, Griffith University # The Preparation of Teachers in Australia
Finland	Students Eligible to Enrol into Maths course <sup>v</sup> 2002-2006	Bachelor Graduates * 2003-2007	Master Graduates UoH + 1970-2007	PhD Graduates * 2003 - 2007		Employment Destinations Bachelor Graduates * 2006					* Statistics Finland University Of Helsinki data
France	Science Bacc Students with Math Major + 1960-2007	Bachelor Enrolments # 1994 - 2003 Bachelor Graduates * 1996-2007	Master Graduates * 1996-2007	PhD Gradautes * 1996-2007				Recruitment of Secondary Maths Teachers * 1960 - 2008			* Michèle Artigue & Pierre Amoux + Rise & Fall article DMEST # Daniel Duverney article
Hong Kong	A Level Maths Passes * 1993 - 2008	Bachelor Enrolments * 1993 2008 Bachelor Graduates * 1993 - 2008	Taught PG Enrolments * 1993-2008 laught PG Graduates * 1993 - 2008	Research PG Enrolments * 1993-2008 Research PG Graduates * 1993 - 2008							* Hong Kong Annual Digest of Statistics - online & via Frederick Leung
ZN	NZY13 Cohort 1963 - 2007	Bachelor Graduates * + 1960-2008 Honours Graduates * + 1964 - 1991	Masters Graduates +* 1960-2008	PhD Graduates *+ 1966-2008	Bachelor Graduate Destinations # 1991 - 2007	Employer Destinations Bachelor Graduates # 1991 - 1996	Maths ITT as % of cohort <u>A</u> 1999-2008		Age of Secondary Maths Teachers ⊥ 2004		* Education Statistics Reports + Individual Universities VEVCC Graduate Outcomes Reports Lacather Census - MinEdu Δ PPTA
Portugal		Bachelor Graduates * 1996. 2008	Masters Graduates * 1996 2008	PhD Graduates * 1990 - 2008							<ul> <li>* Gabinete de Planeamento, Estratégia, Avaliação e Relações Internacionais.</li> <li>www.gpeari.mctes.pt/</li> </ul>
Scotland	Highers Entries 1963 2007 + Maths Highers Passes * 1986-2009										* SQA Online reports + Norman Reid
Taiwan		Bachelor Graduates * 1991 <sup>.</sup> 2007	Masters Graduates * 1991 <sup>.</sup> 2007	PhD Graduates * 1991-2007							* Fou-Lai Lin
ž	A Level Maths Entries * 1991-2008 A Level Maths Passes * 1960-2008	Entrants into UG Maths + 1996 2003 Graduate Numbers + 1960-2007		PhD Graduates + 1995-2007	Bachelor Graduate Destinations + 1969-2007	Employer Destinations Bachelor Graduates + 1972-1994	Entries to Secondary Maths Teacher Training <sup>4</sup> <u>Irainee Teachers</u> with 2:1 or better <sup>4</sup> 1997 - 2008	Employment Status of Secondary Maths Teachers ± 1997 - 2008	Age of Secondary Maths Teachers ¢ 2007	Tertiary Studies of Maths Teachers ¢ 2007	* Inter Examination Board Statistics + Hesa.ac.uk 1 Training and Development Agency for Schools ¢ SSCSS
NSA	Maths courses taken * 1982/1994/2004	Graduate Numbers + 1966-2006 Enrolments & Degrees + 1976-2005	Masters Graduates + - 1970 - 2005 (	PhD Graduates + 1966 - 2006 Migration of PhD Graduates # 1998 2002	Bachelor Graduate Destinations # 1992 - 2002					Percent of Maths Teachers with Highest Degree Eamed 1994-2004	<ul> <li>National Centre for Education Statistics</li> <li>+ AMS - Annual Survey of Mathematical Sciences.</li> <li># NSF - Characteristics of College Grads</li> </ul>