

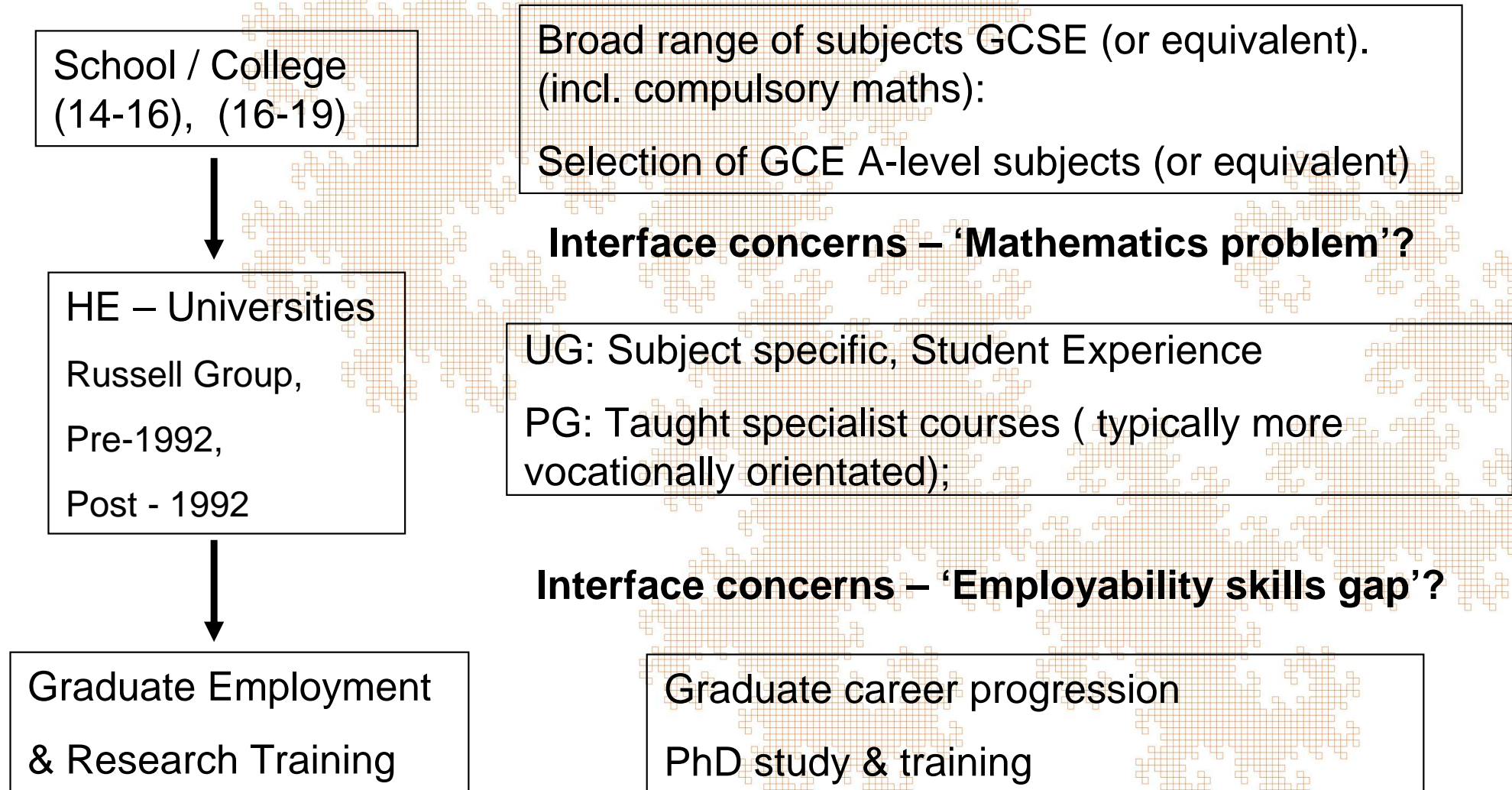
Breadth versus Depth in Mathematics: Upskilling or Dumbing Down?

Joe Kyle & Michael Grove, University of Birmingham

J.Kyle@bham.ac.uk

M.J.Grove@bham.ac.uk

Progression – students to graduate careers



Employability uncovered?

‘70% of employers agree that degree results alone are not the best measure of employment potential’.

Graduates in the Eyes of Employers (2002)

‘Based on a survey of 200 employers (including BMW Group, Logica and PricewaterhouseCoopers), verbal communication is the quality that most employers seek in graduate recruits. This is followed by enthusiasm and written communication skills. Problem-solving ability, numeracy, business awareness and team work are also rated highly’.

From Learning to Earning (2002)

Mathematics in the workplace

‘Some of the most important traits in non-academic mathematicians include:

- skill in formulating, modelling, and solving problems from diverse and changing areas;
- interest in, knowledge of, and flexibility across applications;
- knowledge of and experience with computation;
- communication skills, spoken and written;
- adeptness at working with colleagues (‘teamwork’).

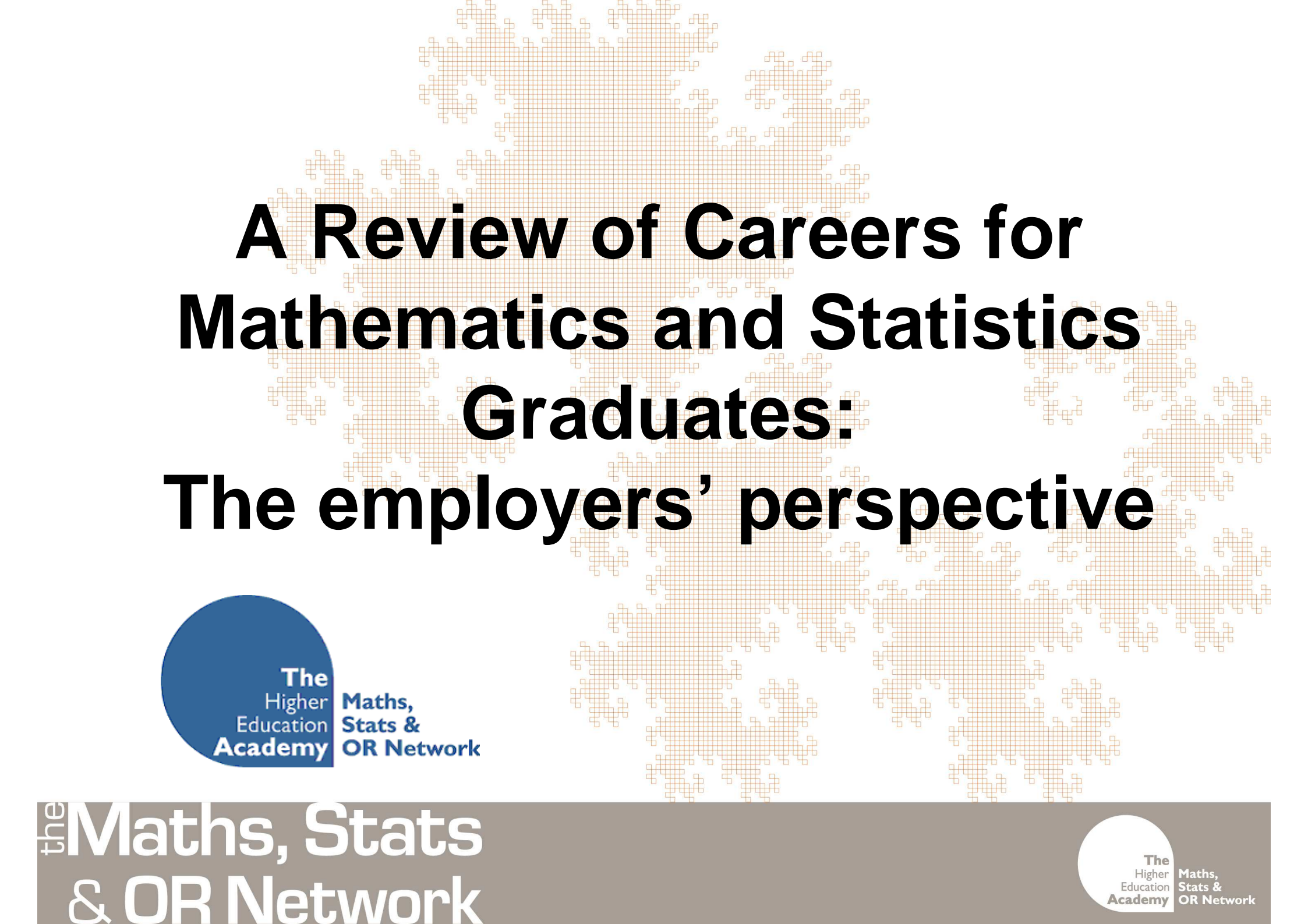
The SIAM Report on Mathematics in Industry (1995)

Mathematics in the workplace

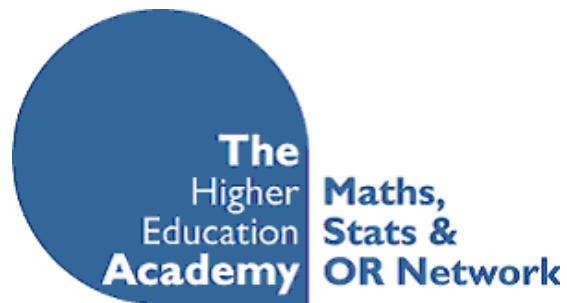
‘The qualities that distinguish these mathematicians from other scientists and engineers are seen by their managers as falling into two broad categories:

- highly developed skills in abstraction, analysis of underlying structures, and logical thinking;
- expertise with the best tools for formulating and solving problems’.

The SIAM Report on Mathematics in Industry (1995)



A Review of Careers for Mathematics and Statistics Graduates: The employers' perspective



Background to the study

- Funded by the Higher Education Academy in 2005;
- Work undertaken by Christine Hirst & the Centre for Education & Industry at Warwick University;
- Report produced March 2007.

Work undertaken by the study

- Six case studies. Each industry-based, providing examples of the types of graduate jobs available for mathematics and statistics graduates, as well as employers' expectations in terms of skills and abilities.
- Methodology consisted of interviews with graduate recruiters from six companies. That:
 - Examined the possible ways employers target mathematics and statistics graduates;
 - Reviewed career pathways and recruitment processes;
 - Considered the academic qualifications and competencies that employers require; and
 - Looked at professional development and career prospects.

Key findings

'...when employing from specific disciplines mathematics and statistic graduates were sought on the basis of their academic qualifications as well as numerical, analytical and generic skills and abilities. In terms of all disciplines, they became part of a pool of graduates from all degrees, where academic requirements were standard and they were assessed in terms of a certain set of competencies'

Competencies & their priority level

- Graduate recruiters at companies surveyed asked to consider a list of competencies/skills developed by the Higher Education Academy in their Student Employability Profiles.
(<http://www.heacademy.ac.uk/ourwork/learning/employability/disciplines>)
- Each competency rated on a scale of 1 (crucial) to 4 (not important) to indicate how significant they were in terms of employing mathematics and statistics graduates.

Mathematical skills

Table 3: Competencies and Skills		CYT	CSA	CLK	CDF	CAZ
		Job	J/TP	Job	J/TP	J/TP
1	Demonstrate knowledge of key mathematical concepts and topics.	2	3	1	5	4
2	Abstract the essentials of problems and formulate them mathematically and in symbolic form so as to facilitate their analysis and solution.	2	4	1	5	3
3	Present mathematical arguments and the conclusions from them with accuracy and clarity.	2	3	2	5	2
4	Have skills relating to rigorous argument and solving problems in general, and a facility to deal with abstraction including the logical development of formal theories.	2	2	2	5	2
5	Have skills relating to formulating physical theories in mathematical terms, solving the resulting equations analytically or numerically, and giving physical interpretations.	2	2	2	5	4
6	Focus on statistics that will have skills relating to the design and conduct of experimental and observational studies and the analysis of data resulting from them.	2	3	1	5	3
7	Have skills relating to formulating complex problems of optimisation and interpreting the solutions in the original contexts of the problems.	2	3	1	5	2

Mathematical, Numerical and Analytical Skills

Generic or 'graduate' skills

Table 3: Competencies and Skills			CYT	CSA	CLK	CDF	CAZ
			Job	J/TP	Job	J/TP	J/TP
8	Have the ability to learn independently using a variety of media.		1	3	2	2	2
9	Work with patience and persistence, pursuing problem solutions to their conclusion.		2	3	2	1	2
10	Have good general skills of time management and organisation.		1	3	3	2	1
11	Be adaptable, in particular displaying readiness to address new problems from new areas.		1	2	2	2	1
12	Transfer knowledge to assess problems logically and to approach them analytically.		1	1	1	1	1
13	Have highly developed numeracy and Information, Communication and Technology (ICT) skills.		2	3	3	2	3
14	Have communication skills such as the ability to write coherently and clearly.		2	2	3	2	1
15	Apply concepts and principles in loosely-defined contexts, showing effective judgement in selecting and applying tools and techniques.	Generic Skills	2	2	2	2	2
16	Demonstrate appropriate transferable skills and the ability to work with relatively little guidance or support.		2	2	3	2	1

“[The UK Government will] ... pursue global excellence ... the benefits of science in society, and deliver science, technology, engineering and mathematics skills in line with employer demand”

The Right Hon Gordon Brown, 2007

"We strive to develop graduates who are prepared for the future, ready for the changing needs of the workplace, and trained for a life of ongoing learning and professional success."

His Excellency Sheikh Nahayan Mubarak Al Nahayan, UAE, 2008

An emerging national agenda?

Agenda for Science, Technology, Engineering and Mathematical Skills (STEM)

- Roberts Report: SET for Success (2002) – HM Treasury Report
- Lambert Review of Business - University Collaboration (2003) – HM Treasury Report
- HEFCE Advisory Group Report (2005) – Strategically important and vulnerable subjects
- Leitch Report – Review of Skills – Prosperity for all in the global economy – world class skills (December 2006) - HM Treasury Report
- DIUS – Higher Education at Work – High Skills: High Value Consultation Document – April 2008

Royal Society (June 2006, October 2006 & January 2008):

- Science Higher Education in 2015 and beyond – call for evidence.
- A degree of concern? UK first degrees in science, technology and mathematics.
- A higher degree of concern ?

Key findings

“...it seems that firms are becoming increasingly reliant upon graduates having particular sets of competencies as well as academic qualifications. Consequently universities need to be mindful of this in terms of career advice and the preparation of undergraduate programmes”.

National Student Survey – graduate viewpoint



‘Personal development’

- ❖ The course has helped me to present myself with confidence
- ❖ My communication skills have improved
- ❖ I feel confident in tackling unfamiliar problems

‘Personal development’ Maths was the **lowest** in of **all** subjects 3.7 / 5 (2005 & 2006)

Subject area	Personal development (2006)		
	Q1	Med	Q3
(10) Physical Science	3.9	4.0	4.1
(12) Mathematical Sciences	3.6	3.7	3.9
(13) Computer Science	3.8	3.9	4.0
(14) Mechanically-based Engineering	3.9	4.0	4.1
(25) Business	3.9	4.0	4.1
(26) Management	3.9	4.0	4.1
(27) Finance and Accounting	3.8	4.0	4.1

Results for Mathematical Sciences (average values) - 2007

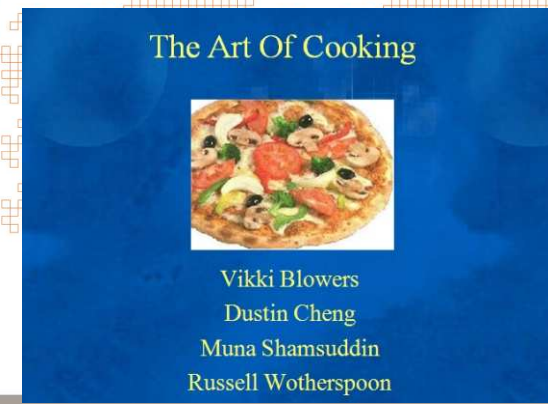
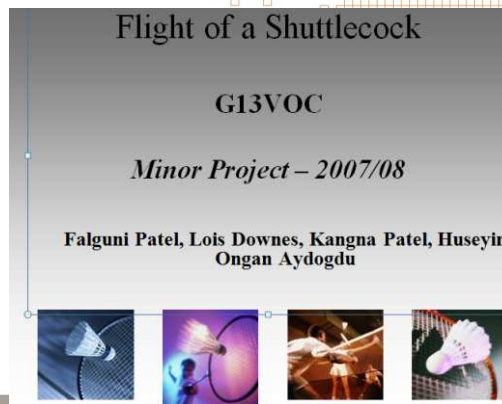
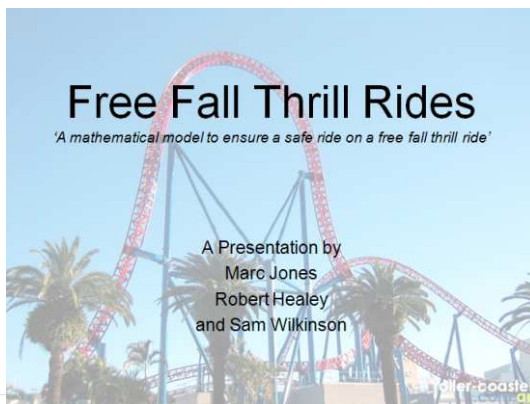
[HEFCE Website](#)

The Teaching on my course	Assessment and feedback	Academic support	Organisation and management	Learning resources	Personal development	Q22 - Overall satisfaction	Response Rate
82%	67%	79%	81%	85%	69%	89%	66%

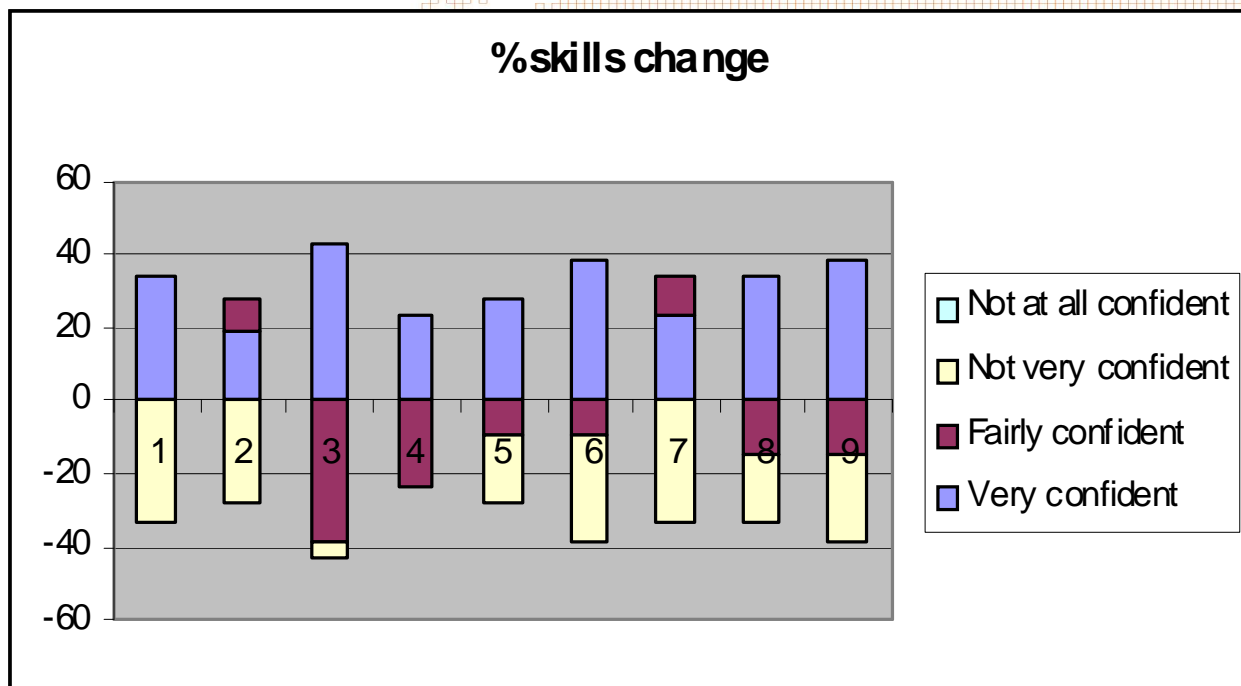
Vocational Mathematics - highlights

Module highlights:

- Skills Workshops
- Personal Evidence Database (PED) provided
- oral reports (20%) & Written reports (80%)
- minor-project 33%, major project 67%
- plagiarism report provided
- group progress tutorials
- oral report videoed, peer assessed and uploaded onto the web
- peer adjudication for individual contribution (scaling)
- detailed profile feedback & comments



Student Evaluation – Change in Skills



Skills

1. writing a mathematical report
2. making an oral presentation
3. contributing to group discussions
4. working as part of a team
5. expressing problems in a mathematical language
6. interpreting mathematical results in real-world terms
7. interpreting open-ended coursework questions
8. organising material for a written report
9. structuring a written report

- <http://www.youtube.com/watch?v=ujks0lSj-RI>