

Building Confidence in Mathematics and Statistics

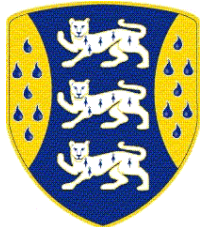
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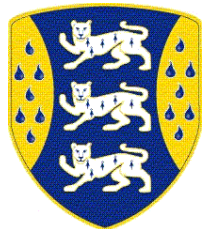


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Overview of Session

- ⊕ Introduction
- ⊕ Issues: Here and Nationally
- ⊕ Harper Adams' Mathematics, Statistics and Support
- ⊕ Research, Findings and Conclusions
- ⊕ Resources and Workshops
- ⊕ Time for Discussion



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Harper Adams Background

- ⊕ Small, friendly HE college, specialising in land-based subjects, including engineering
- ⊕ *Aspire CETL - Advancing Skills for Professionals in the Rural Economy*
- ⊕ 1700 FTE students (approx.)
- ⊕ All students are taught some Mathematics/Statistics
- ⊕ Mathematics Support since 2001
- ⊕ Agriculture subject has 2nd highest levels of dyslexia nationally (HESA)



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Past Mathematics Difficulties

- ⊕ Past high failure rates in
 - ⊕ 1st year engineering mathematics modules (HND in 1999/2000)
 - ⊕ College wide first year statistics modules (2000/1)
- ⊕ Student difficulties in other mathematical subjects
- ⊕ Research paper concluded *'there was a strong (95 to 98%) probability that the lack of GCSE Mathematics Grades 'A' to 'C', was a significant factor in the withdrawal of students from the 1995 HND and Degree entry to the college.'* (Cowap, 1998)

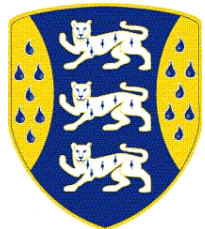


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Widespread Difficulties in Universities

- ⊕ Hawkes and Savage, 2000. Compared successive engineering student cohorts unfavourably in the report '*Measuring the Mathematics Problem.*'
- ⊕ Mustoe, 2003. '*For many years concern has been expressed about the decline in mathematical skills possessed by entrants to engineering and science degree programmes.*'
- ⊕ Kent and Noss, 2003. *The mathematics problem is usually described as a skills problem, but this has two aspects: the knowledge of mathematical techniques/facts, and the confidence to make use of them.*

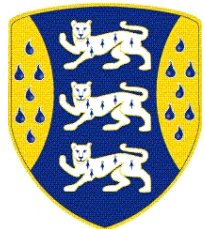


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National Issues with Mathematics

- ⊕ Government Inquiry into Post-14 Mathematics
'Making Mathematics Count', Prof. A. Smith. 2004.
One of 3 key issues found was 'the failure of the current curriculum, assessment and qualifications framework to meet the needs of many learners and to satisfy the requirements and expectations of employers and higher education institutions.'
- ⊕ Ken Boston, 2006, QCA Chief Executive, describes the teaching, curriculum and assessment of mathematics as 'as one of the most challenging areas in contemporary education.'

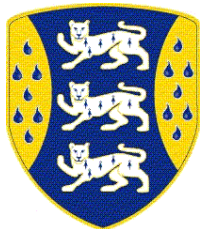


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Changes to Harper Engineers' Mathematics from 2001

- Curriculum changed to include revision of GCSE. BEng students taught the original content, plus GCSE revision.
- Provision of Lecture handouts
- Provision of Mathematics Support
- Screening of new students, initially 1 hour test, plus 10 minute test. 10 minute test now sufficient. Weaker students encouraged to seek support.
- Students taught separately for B/MEng, BSc and HND/FdSc award levels (approx. 20 students).
- Excellent results: Mean marks often in 60%'s & 70%'s



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Mathematics Support

- ⊕ Sarah Parsons employed as Part-time Support Tutor from September 2001, now based in the Aspire Centre
- ⊕ Support available as:
 - ⊕ Individual appointments booked in advance
 - ⊕ Small group support for students on maths/stats modules, usually weekly
 - ⊕ One-off workshops for maths topics related to courses. e.g. elasticity in economics, drug calculations for vet nurses, valuations for surveyors
 - ⊕ Revision / Assignment Support (large class drop-ins)
 - ⊕ Support materials: e.g. for Statistics, mathcentre, etc.



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Subjects Supported

- ⊕ First Year Engineering Mathematics
- ⊕ Second Year Engineering Mathematics
- ⊕ First Year Mechanics
- ⊕ First and Second Year Statistics
- ⊕ Excel, SPSS, Genstat and mathcad packages
- ⊕ Dissertation/Project Analysis
- ⊕ Mathematical topics across college



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Student Support Comments from College Feedback 2006/07

'Lots of extra help if required'

'Excellent, thoughtful support'

'Very helpful support'

Engineering Students

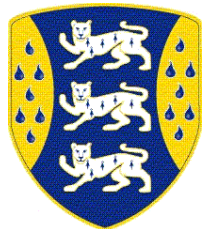
*'Taught us for statistics – broke it all down into 2 hours
helped with assignment – very useful'*

Veterinary Nursing Student

'Very thorough and explained well'

Surveying Student

'Students definitely need her'



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Aspire Development Fellowship 2005/6

- ⊕ Students' Learning of Mathematics and Statistics
- ⊕ Fellowship comprised three distinct areas:
 - ⊕ Pedagogic research into students' learning of mathematics and statistics
 - ⊕ statistics resource development for integration with a separate Research Methods Resources project, and
 - ⊕ development and delivery of workshops to support numerically weak first year students.



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Research Aims

- ⊕ To understand better the students' experiences learning mathematics and statistics
- ⊕ To provide a student '*voice*'
- ⊕ Research Questions (abbreviated) include:
 - ⊕ What is the effect of students' self-confidence in mathematics on their learning?
 - ⊕ What evidence can be found for the effect of mathematics support?
 - ⊕ What differences can be identified for the needs of students with dyslexia, dyscalculia and/or other needs when learning mathematics and statistics?



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Methodology

- ⊕ Student questionnaires were administered in mathematics and statistics lectures by lecturers
- ⊕ Questionnaire numbers:
246 in 2005, 277 in 2006 and 179 in 2007
- ⊕ Engineering first and second years, re. Mathematics
- ⊕ Natural Science students re. Statistics, Excel & Genstat
- ⊕ Social Science students re. Statistics, Excel & SPSS
- ⊕ Overall good response rates achieved (e.g. 63%)
- ⊕ Responses analysed using Excel, Genstat and SPSS
- ⊕ Research supervised by [Loughborough University](#)

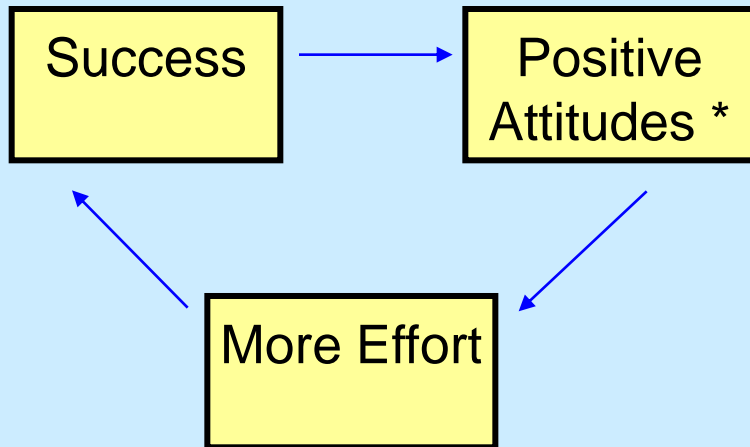


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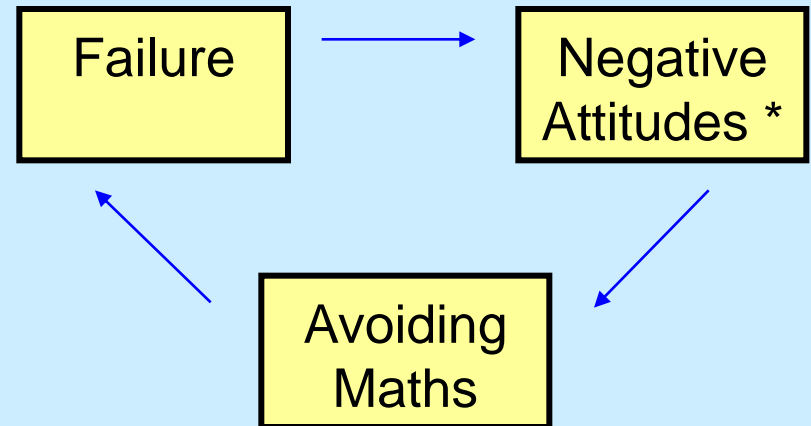


Success Cycles in Maths

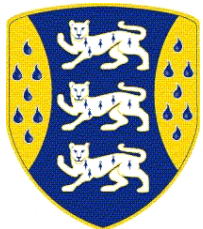
The Success Cycle in Maths



The Failure Cycle in Maths



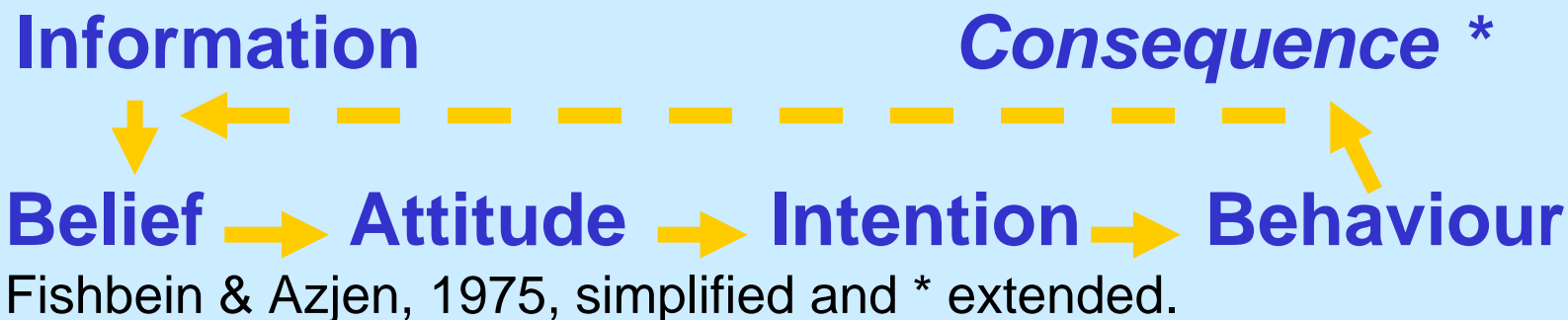
Ernest, P. 2000



* Added by S Parsons, to include 'Confidence'
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Causal Chain of Beliefs, Attitude Intention and Behaviour



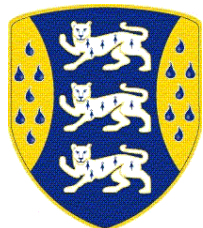
Confidence is a belief: *'I can do maths'*

'I have never felt myself able to do mathematics'

Other beliefs: *'Maths is difficult'*, *'Maths is useful'*

Attitudes: Like or dislike mathematics, etc.

Intention / behaviour: Working at mathematics



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Open and Closed Questions

- ⊕ Students rated their self-confidence in mathematics, statistics and life, and for various topics studied in the module (5 point Likert Scales)
- ⊕ Open questions related to students' attitude to mathematics/statistics, effects of dyslexia/dyscalculia, what had helped or hindered their learning.
- ⊕ Questions regarding mathematics support
- ⊕ Responses were analysed with student marks (if student id no. was provided)
- ⊕ Analysis by Descriptive Statistics, ANOVA, Regressions, Cluster and Factor analysis techniques.



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Main Findings

- ⊕ Better maths entry qualifications were associated with better confidence and attitudes and higher achievement in mathematics and statistics at university.
- ⊕ Engineering students were more positive than other students towards learning mathematics/statistics.
- ⊕ Confidence and attitudes were long-established, with mainly improvement (or no change) at Harper
- ⊕ Mathematics Support was frequently stated as helpful
- ⊕ Dyslexia did not have a significant effect on marks
- ⊕ Computers were particularly helpful for learning statistics



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Findings for Engineers'

Mathematics Modules 2005-7

- ⊕ Engineers have **medium confidence** on average: Life > Maths > Stats
- ⊕ Majority (overall 71%) would choose to study Engineering Mathematics
- ⊕ More motivated than non-engineers
- ⊕ Common helpful attitude – *'has to be done'*, *'Maths is necessary'*, *'get on and do it'*
- ⊕ 41% used Maths Support, mean rating of 4.7 out of 5



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Findings for Non-Engineers' Statistics Modules 2005

- ⊕ **A2, AS and GCSE Grade A/A*** are confident
Confidence in Maths > Stats > Life
- ⊕ **GCSE Grade B and below** are not confident
Confidence in Life > Maths > Stats
- ⊕ **Only maths A2 students would choose** to study the statistics (some of whom were bored)
- ⊕ **70+% students are reluctant to study statistics**
- ⊕ 18% used Maths Support, mean rating of 4.1 out of 5



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GCSE Grade B students

Learning Statistics

- Surprise that Grade B are not confident
- A quarter rate Confidence = 1 or 2
- 54% rate Maths below Life confidence
- Grade B student comment examples:

'Bad experiences with maths previously have made me have little confidence in my maths ability now. So don't try very hard as believe will get it wrong anyway.'
(Intermediate tier)



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GCSE Grade B Student Negative Previous Experiences

'A lot, didn't like it from the start and my opinion hasn't changed'

*'Affected it greatly, already had a dislike to maths so consequently don't like anything to do with numbers now.
(Higher tier)*

'Definitely knocked my confidence at school' (Higher tier)

Maths at GCSE level was boring, causing a repulsive reaction to APD stats (Higher tier)

Quotes from first year natural and social science students learning statistics



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% Students who would Choose to Study Maths/Stats

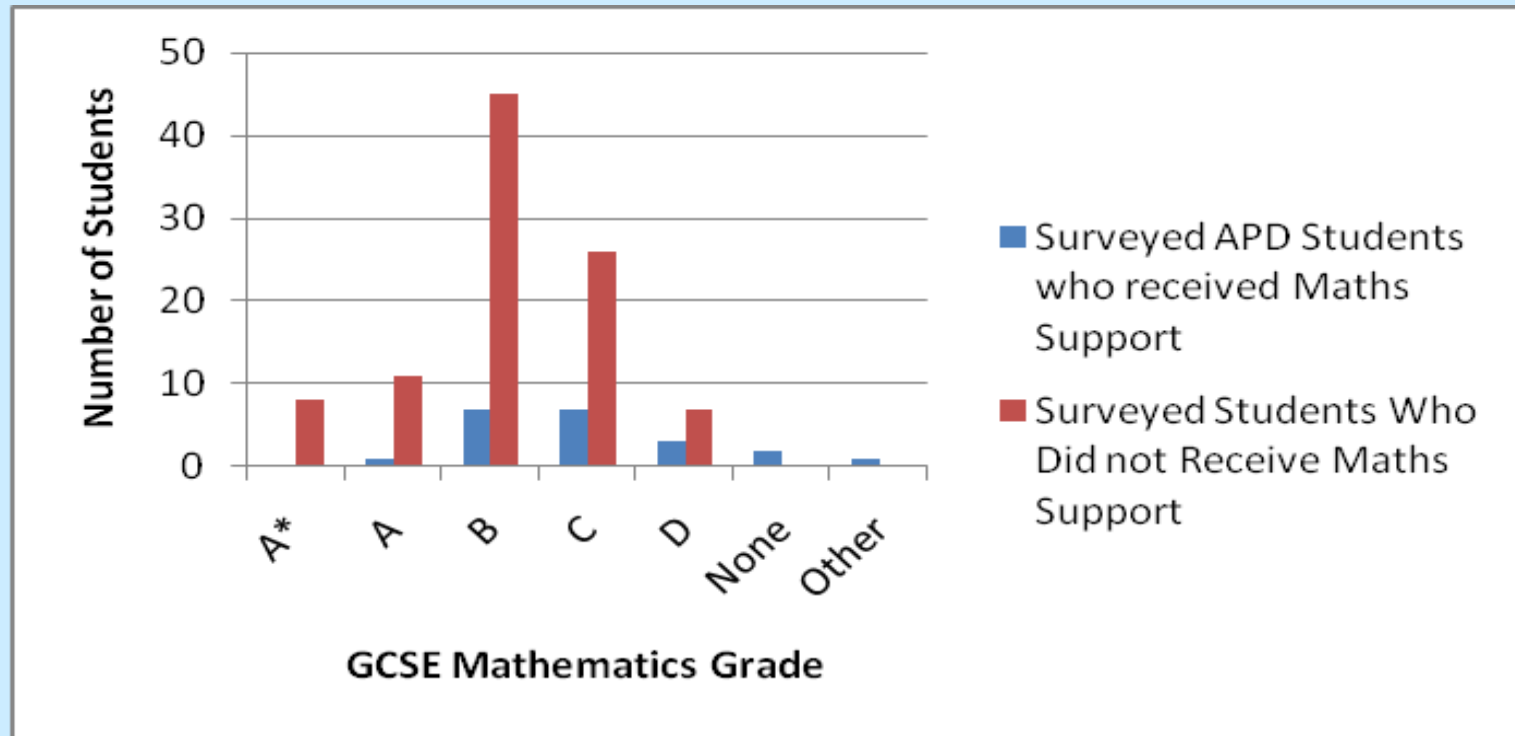
Module	%
1st Year Engineers' Mathematics:	
MEng and BEng	83%
BSc students	100%
HND students	50%
2nd Year Engineers' Mathematics	82%
1st Year Statistics	31%
2 nd /3 rd Year Natural Scientists'	44%
2 nd /3 rd Year Social Scientists'	35%



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1st Year Students' Stats Support



Supported students had lower GCSE Maths Grades
Within Grades supported student marks were 3-4% higher



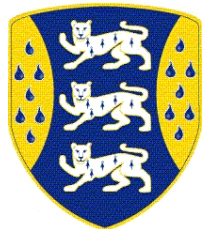
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Second Year Natural Science Students

What Helped Students' Learning	No. responses
Doing exercises	13 (or 17*)
Practise tests at start of lecture	6
Lecturer	5
Genstat / Use of Computers	4*
Lecture Notes	3
Various other (none more than 2)	<u>10</u>
Total	41

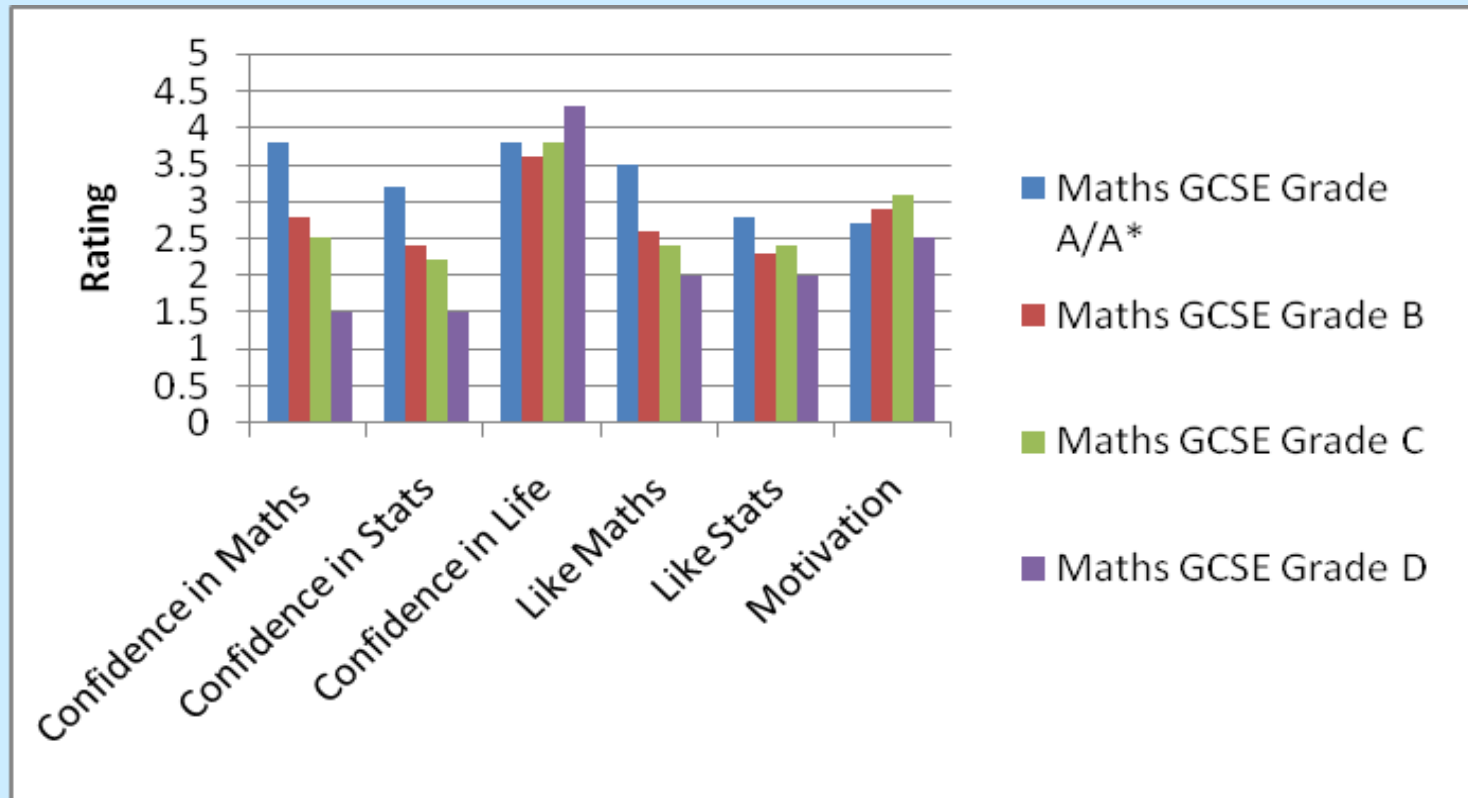
n.b. Maths support not promoted to 2nd year students in 2005



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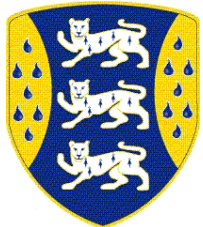


2nd Year Social Science Students' Confidences

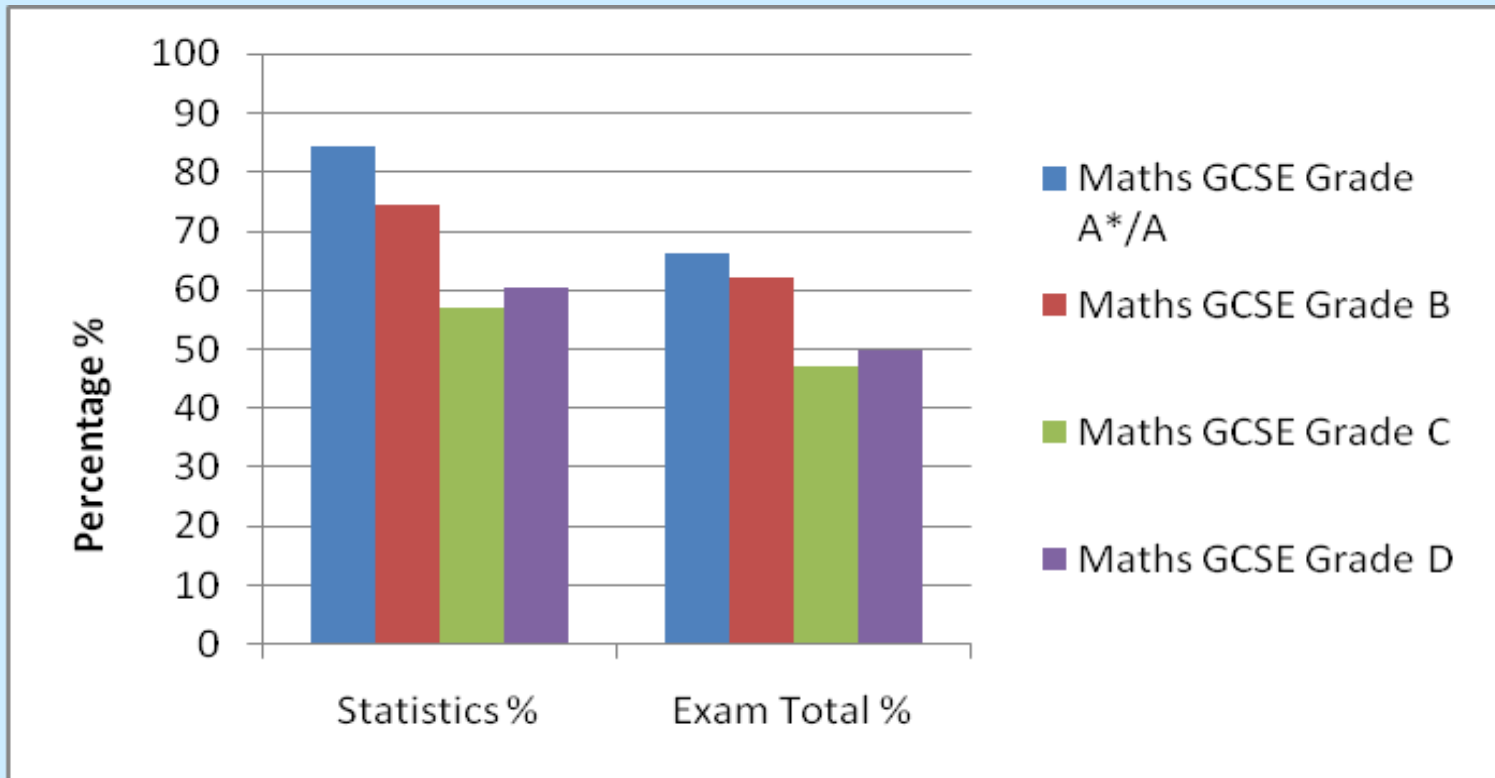


Most confidences are low, below 3

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2nd Year Social Science Statistics Exam Marks

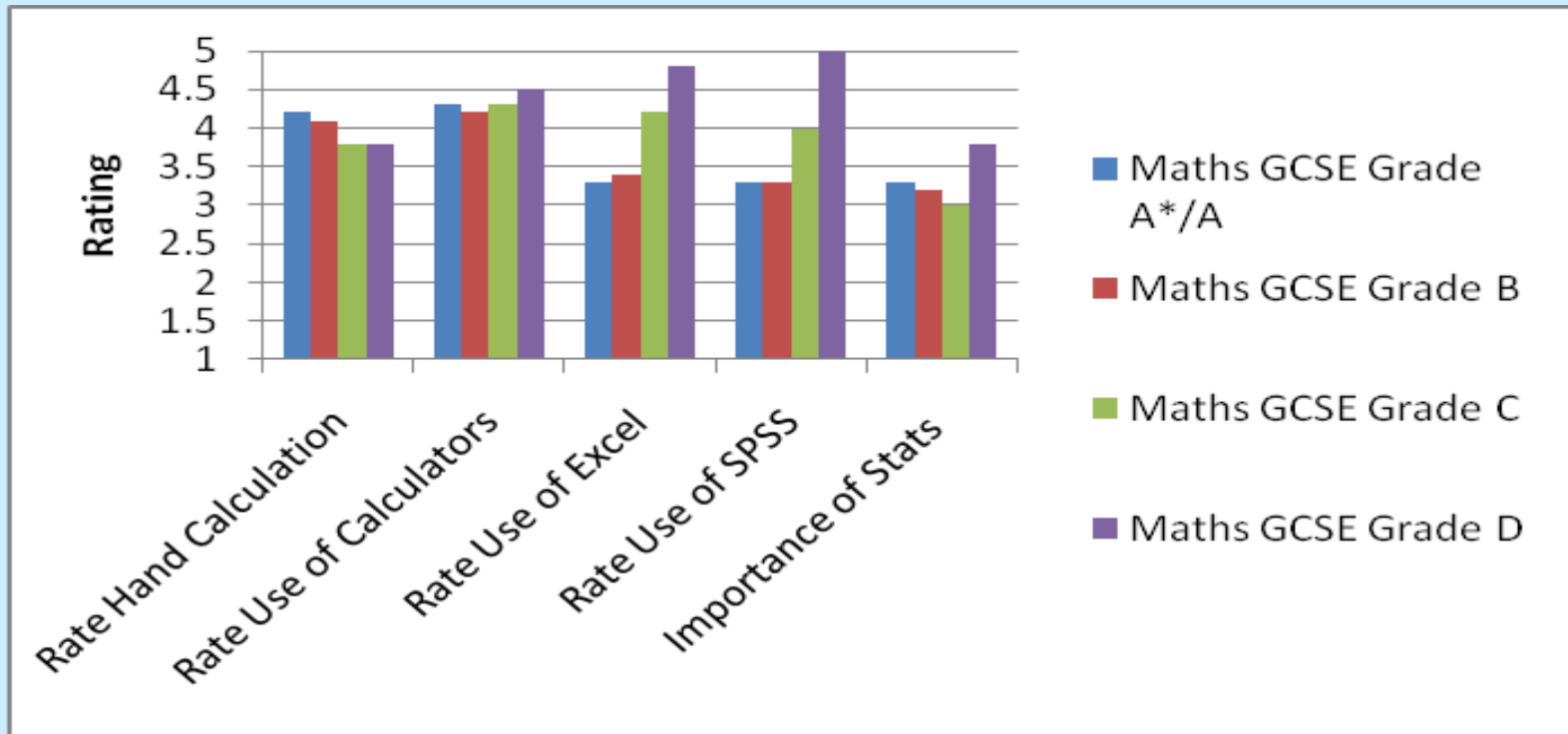


Marks for statistics questions were high

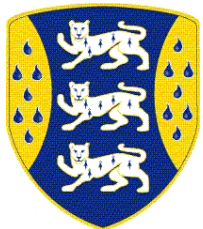
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2nd Year Social Science Calculation Method Ratings



Students rated highly all methods of calculation



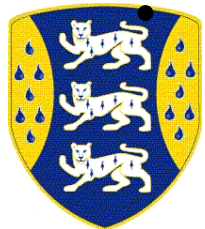
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Other Findings

- **Q. Since when have you felt this level of Confidence in Mathematics?**
 - *Forever / always / a long time*
 - *Since GCSE, 14-16*
 - *72% of first year engineering students felt more confident after Harper mathematics modules*
- **Q. 'When did you last enjoy something in Maths?'**
 - *Never, a long time ago, can't remember*
 - *GCSE, Last week*
- **Practical applications** increase motivation / enjoyment
- **Use of Computers** was most helpful for stats

Mainly positive comments for all modules



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Dyslexic Student Support

- ⊕ Many dyslexic students perceive that they take longer to learn maths/stats
- ⊕ Harper dyslexic students marks' are not significantly different from non-dyslexics'
- ⊕ Responses for 'Effect of dyslexia on learning mathematics. Unfortunately no positive effects stated.
 - ⊕ *'Takes longer to absorb info'*
 - ⊕ *'Takes longer to do calculations'*
 - ⊕ *'Makes it more difficult to understand'*
 - ⊕ *'I don't feel it really affects me'*
 - ⊕ *'Every possible effect.'*



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Workshop Feedback 06/07

- ⊕ Positive feedback was obtained
- ⊕ Good average overall ratings: Valuations 4.4, Elasticity 4.6 and APD Support 4.7 (out of 5)
- ⊕ What students found useful
 - ⊕ *'General clear structure for help with % & valuations'*
 - ⊕ *'All the session. I find maths very hard'*
 - ⊕ *'Step by step ways to do various statistics'*
 - ⊕ *'The summary sheets given were very useful'*
 - ⊕ *'Getting different, slightly simpler notes was useful'*
 - ⊕ *'Was explained so that we could understand'*



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New Statistics Resources

- ⊕ Notes written for ANOVA, Chi-Squared tests and t- tests
- ⊕ Well-received by students, mean rating 4.5 of 5, and high student demand for leaflets
- ⊕ Content:
 - ⊕ Intro / explanatory text
 - ⊕ Examples by hand and computer output
 - ⊕ Recommended books
- ⊕ *'Very detailed, more so than any notes I've had in the past. They also explain what the tests are used for which I've never understood before'*

Veterinary Nursing student



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Challenges for Mathematics Support

- ✦ Difficulty with availability at peak times, e.g. when students leave getting help to close to assignment hand in date
- ✦ Close co-operation with lecturers is necessary for understanding module content and expectations from students
- ✦ Each cohort of students needs encouragement to seek support and some needy students don't seek help



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Conclusions

- ⊕ Success Cycles do exist in Mathematics
- ⊕ Students' Confidence is important
- ⊕ How to show cause or effect?
- ⊕ Engineering students succeed and improve in mathematics at Harper Adams, as do many non-specialist students learning statistics
- ⊕ Mathematics Support makes a positive contribution to student success.
- ⊕ There is always room for improvement



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