maths e.g. – an update Or

Reaching the parts other CAA systems don't!

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CAA at Brunel University

- Mathletics – not *that* Mathletics! Was Question Mark Perception
- Now written in own interface and renamed maths e.g.
- Javascript, MathML, SVG
- Questions database spans GCSE, A-level, undergraduate topics
- Questions database spans MC, NI, RNI, TFU, MR, NI+confidence, Revealed MC etc (no free-form maths input … yet): PROS/CONS?
- Hundreds of users take circa 30,00 tests pa. Students from Economics, Electrical and Electronic Engineering, Financial Computing, Foundations of Engineering, Foundations of IT, PGCE and Sports Science. **Much commonality but not maths!!**
- Low-stakes summative assessment
- Format: best-ever mark from their first 5 attempts counts towards their module mark; not invigilated and group work is allowed/encouraged. **Exam pass required!**

What is an objective question?

<u>Exercise</u> Consider the following question: "Sketch the graphs of $f(x)=x^2$ and $g(x) = x^{1/2}$. Find the area of the lenticular shape between the graphs. Show that this area is twice that of the lenticular areas between $f(x)$ and $g(x)$ and the straight line $h(x)=x$ and explain why this is the case."

This SYNOPTIC QUESTION is far from being objective … and even further from being able to be handled by any CAA system.

Humans can mark this … let's introduce HAA!

-> many atomised follow-on questions

1. *Sketch the graphs of $f(x)=x^2$ and $g(x) = x^{1/2}$.* ***Objective but not CAA ('sketch')***
2. *Find the area of the lenticular shape between the graphs.* ***Objective but not CAA without giving the game away – assumed and tested skills important here, esp if they get it wrong.***
3. *Show that this area is twice that of the lenticular areas between $f(x)$ and $g(x)$ and the straight line $h(x)=x$* ***ditto 3.***
4. *and explain why this is the case."* ***Not objective***

So what SHOULD we do?

- Impossible to answer unless we know the purpose of the test …
- FAIRNESS versus VALIDITY
- Very strict marking scheme (no access to their workings) but this can be a good thing “Computer says no!” e.g. {1,2,3} is NOT 1,2,3
- Group working GOOD or BAD. If bad, CAA is less bad since copying is impossible.
- Use CAA as a bridge to students, usually via email followed by tutorials or lectures.

Do NOT:

- Reject CAA because it can't do everything (modelling, proofs, evaluation, no writing etc) – that would be like refusing to buy a car because it can't fly or go underwater! Clearly blended assessment regimes are needed. There is plenty wrong with *HAA* too: copying and 3-week turn around, limited feedback with no links to extra help …
- Translate existing problem sheets directly – think about the skills involved
- Trust to luck with randoms
- Trust calculators!
- Ignore aliasing/illegal software etc!

$$\int_{8}^{9} x\, e^{x^2}\, dx$$

Do:

- Use a variety of question types
- Trust the students to do the tests and read the FEEDBACK – they will do so
- Let CAA take the strain – use others' material. This simplifies or even removes the administration of tests (vetting, booking rooms, special arrangements, marking, feedback, delivery to students – and then the whole lot again for reappraisals)
- Exploit the media (graphics, multi-media, customisation by students – font/colours and even language?)
- Do something worthy of a human yourself (i.e. talk to students)

MC question

Simplify

$$-3[-1+8q-7q^2-10q^3]+4[-6-4q+7q^2+6q^3+8q^4]$$

- $27-8q-7q^2+6q^3-32q^4$
- $-3-28q+28q^2+36q^3+8q^4$
- $-21-40q+49q^2+54q^3+32q^4$
- $-25-8q+21q^2+14q^3+32q^4$
- None of these!
- I don't know!

Key and distracters always have to be distinct – hard to do with randoms
a^2=2a = 4 when a=2

None of these also on paper-based tests

Submit

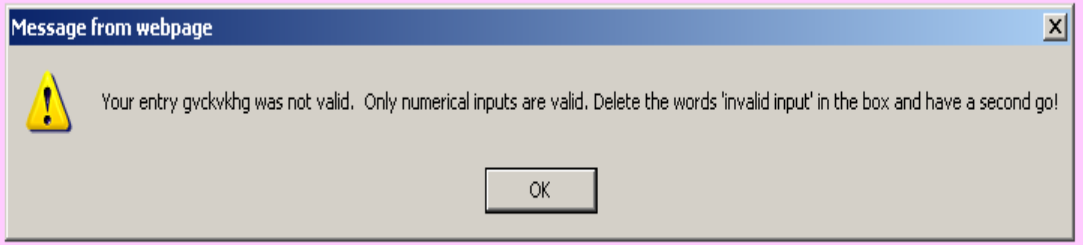
- Malrules – can be surprisingly effective even if 'mechanical or obvious'
- Passive – they only need to spot the correct answer when they see it – use REVEALED MCQ's instead (quite nasty)
- Builds confidence

Necessary but not sufficient

RNI question

If you were to dissolve 1222.62 g of potassium chloride (formula: KCl , MW: 74.55 g/mol) in exactly 3800 ml of water, what would be the molarity of the solution?

Molarity = gvckvkhg M



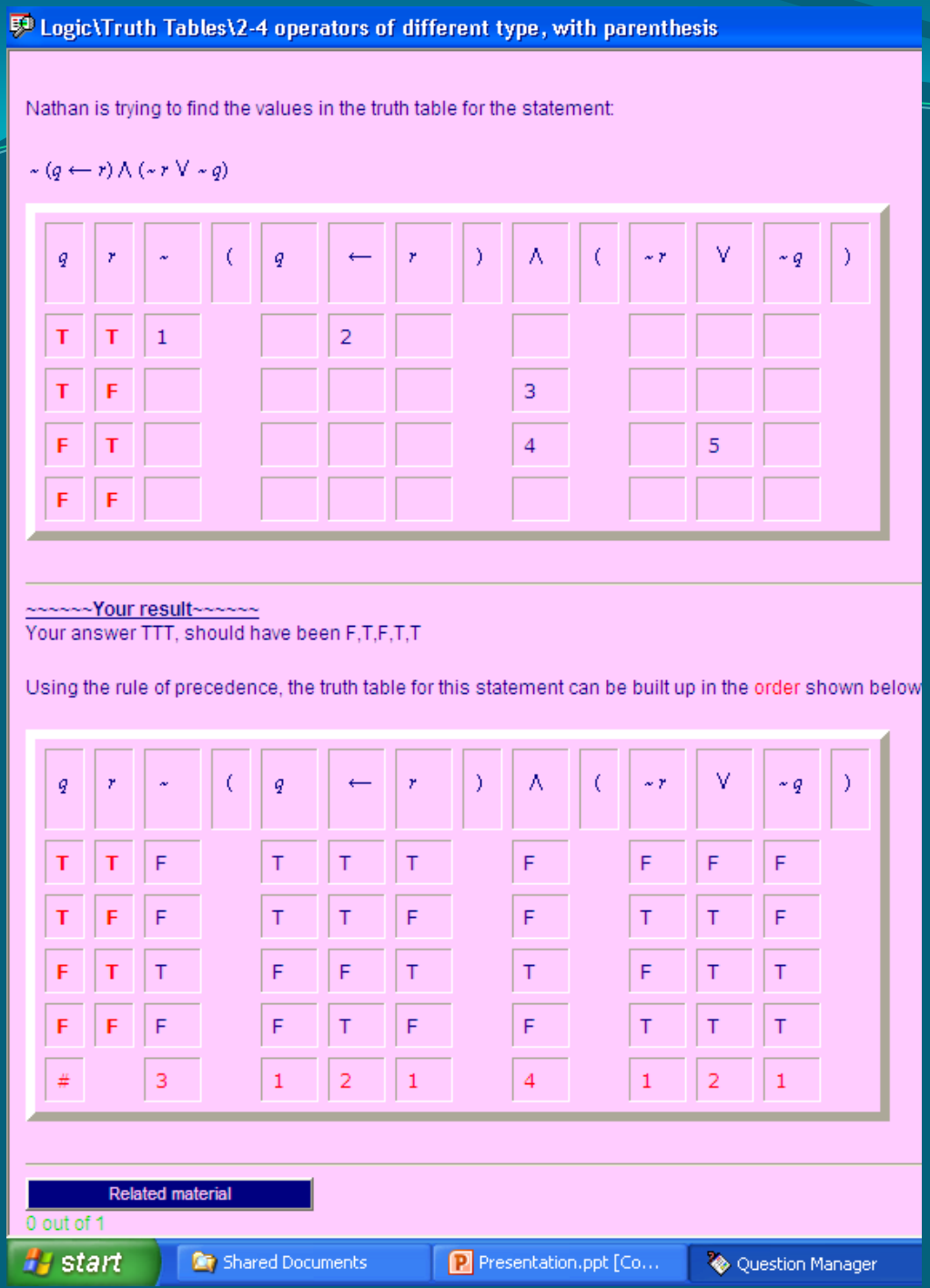
Input your answer in moles per litre, rounded to two decimal places if need be.

- Should check input before marking, forgiving rounding errors
- Many mal-rules programmed 'behind the scenes' (to help students)

4TFUSP question

Statement	T, F or U ?
The races of students (white, black, asian etc) in a questionnaire return are qualitative & ordinal	
The satisfaction levels (high, medium or low) of customers are numerical & continuous	
The ranks of navy personnel are qualitative & nominal	
The numbers of crimes per week reported at a police station are numerical & discrete	

- Statement + Property randomised
- Fonts & Colours
- Low facility – high discrimination
- Made the author think!

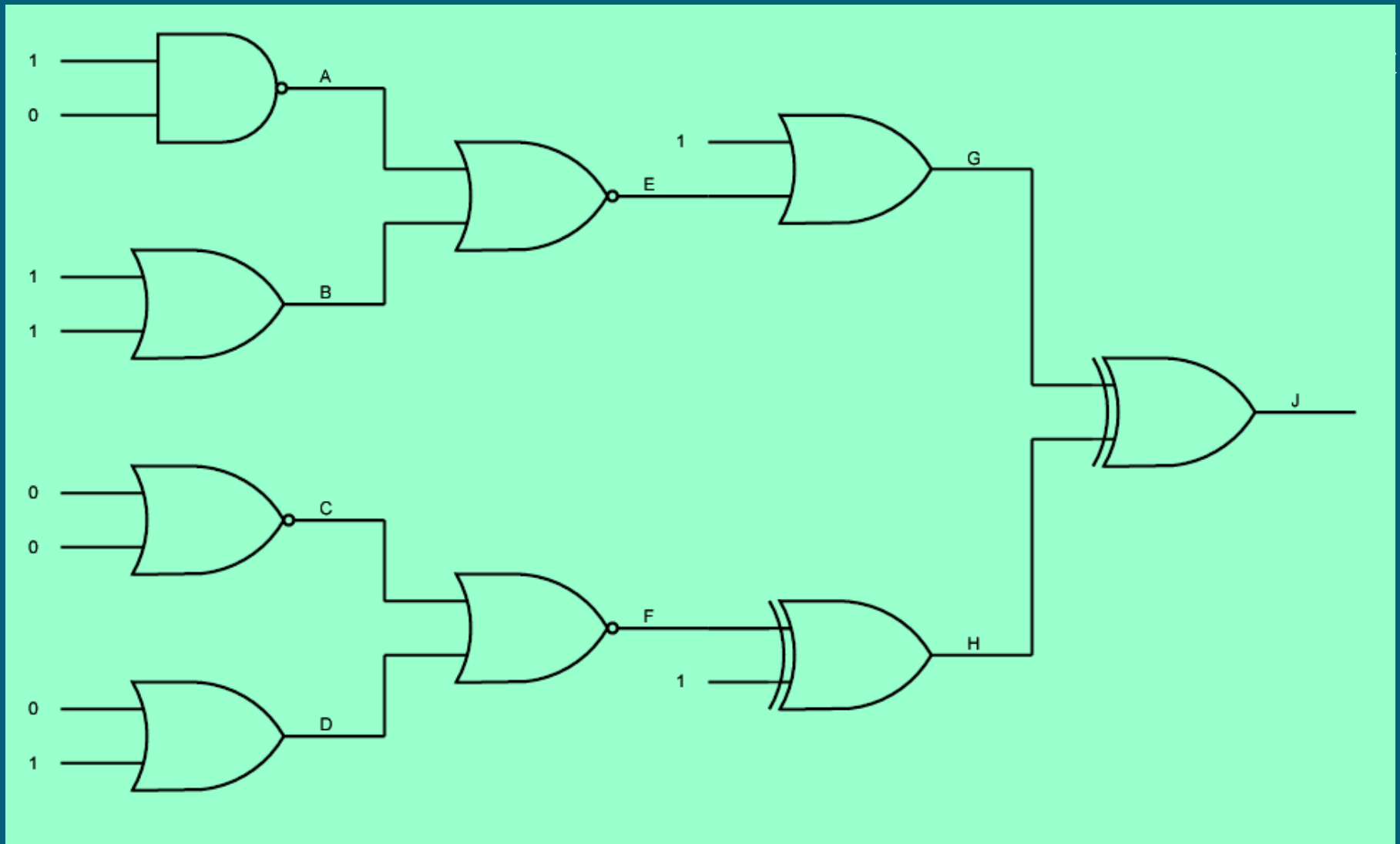


Computer science question

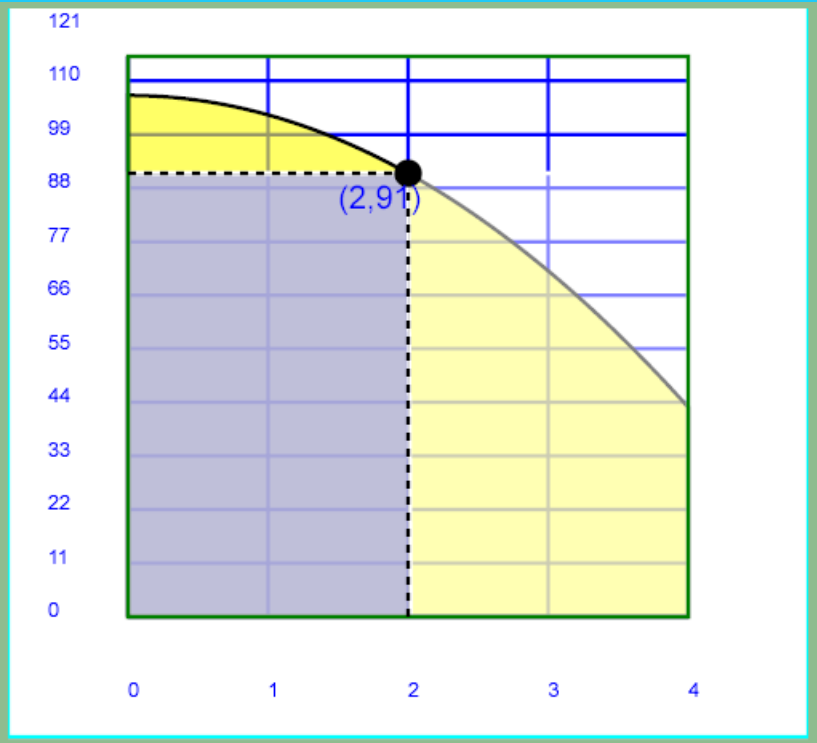
- Pre-processing of input
- Table generated on the fly
- Required element positions randomised

Electronics question asking for A to J values

- inverse problem can also be done (with thought!), could also do random topologies but do we WANT to?



Feedback - contextualised



The consumer surplus is given by the yellow area in the above graph; this is the definite integral under the curve from 0 to 2 minus the area of the blue rectangle of height 91 and width 2 i.e.

$$CS = \int_0^2 \left(107 - 4Q^2\right)\, dQ \quad - \quad 91 \times 2$$

$$= \left[107Q - \frac{4Q^3}{3}\right]_0^2 \quad - \quad 182 = 21.333$$

Related material

- economics question
- part of the formative feedback
- SVG diagram realised according to the random parameters in the question
- related material button links to any web resource (via centrally-held lookup array)

Nurses - contextualised

A patient has been on holiday, during which he was ill. Before going on holiday the patient claims that his weight was 15 st 3 lbs. You weight the patient now and he weighs 83.08kg. How much weight has the patient lost and what is the percentage weight loss in his body weight?

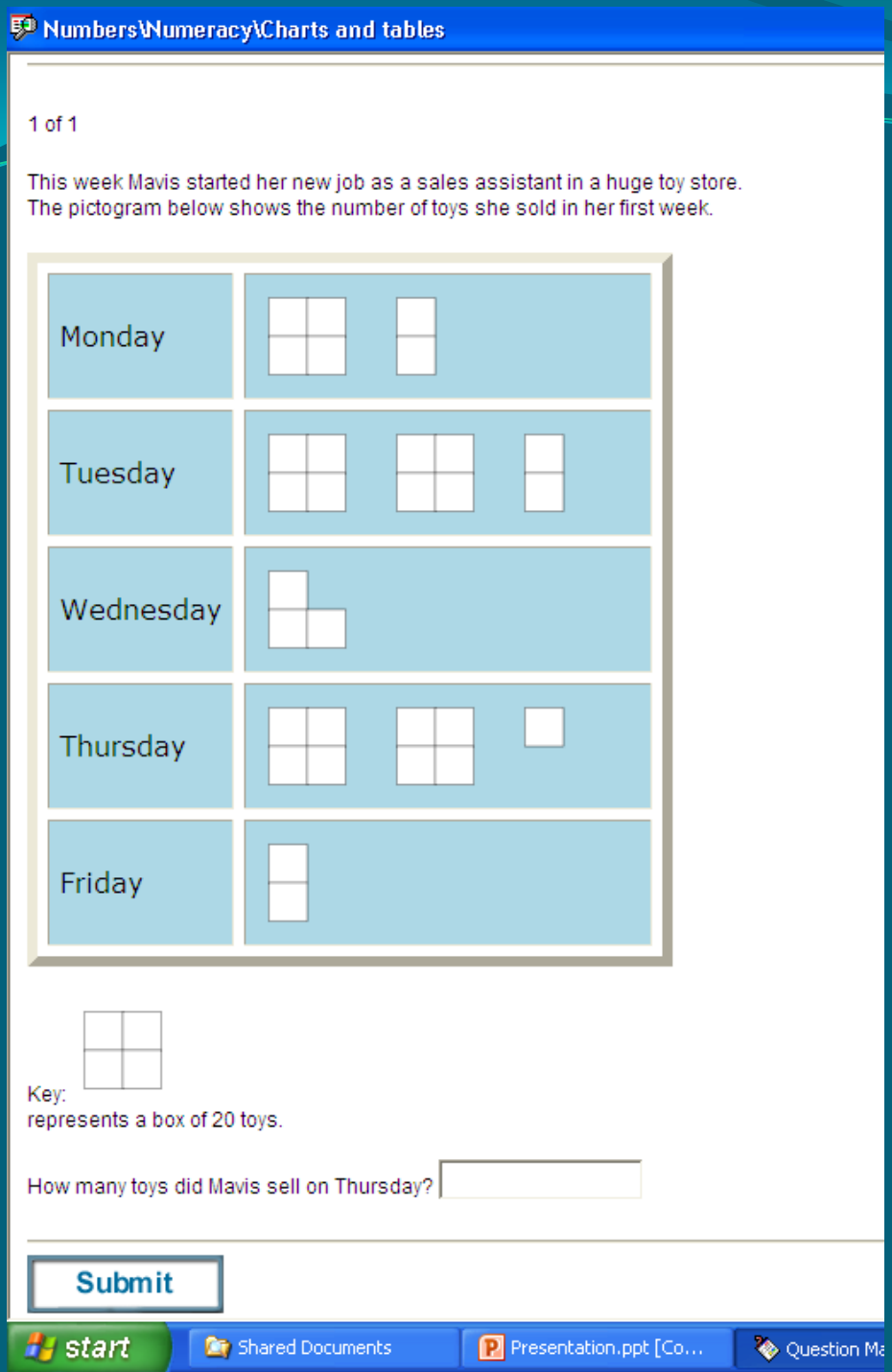
You are given that 1 kg = 2.205 lbs.

Weight loss = _____ kg

Percentage weight loss = _____ %

*Input your value for the weight loss in kg correct to 2 decimal places and percentage weight loss to the nearest percent. Note the question specifies percentage weight **loss** not percentage weight **change** so no minus sign is needed here.*

- The only question with Imperial units!
- Realistic weights
- Realistic weight loss!



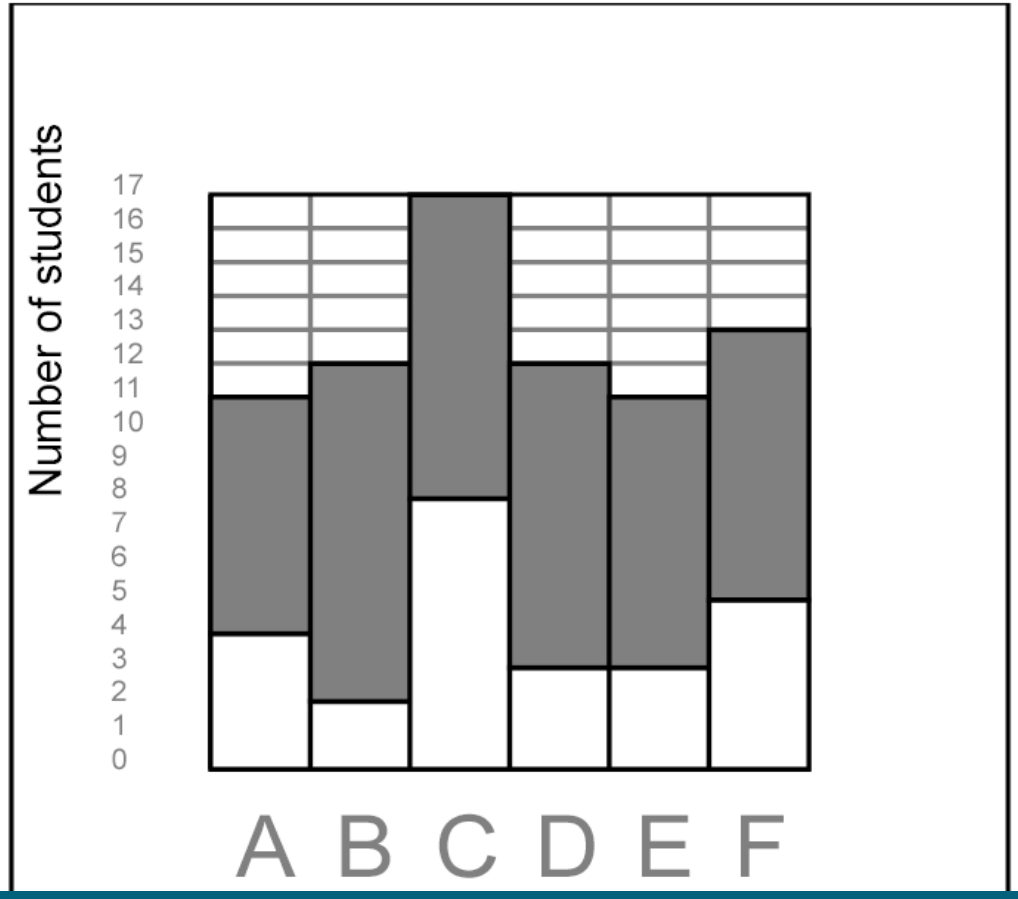
Adult numeracy?

- Pictogram changes
- Scenario changes
- Notice the key -> mal-rule
- 50% of British adults have the numeracy skills expected of a 7-year old …

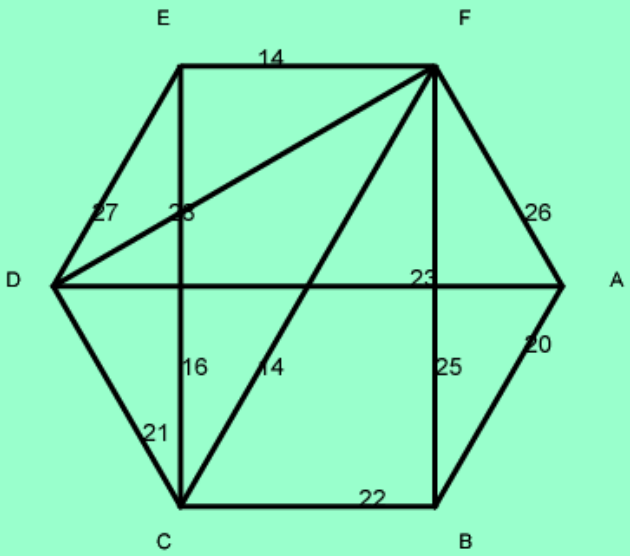
Adult numeracy/aptitude tests

The bar chart below shows the numbers of students taking mathematics in seminar groups A-F at Cardiff University. The white bar in each group denotes women, whilst the grey bar denotes men.

What is the lowest percentage of men in any of the 6 seminar groups? Input your answer in the box, correct to the nearest percent.

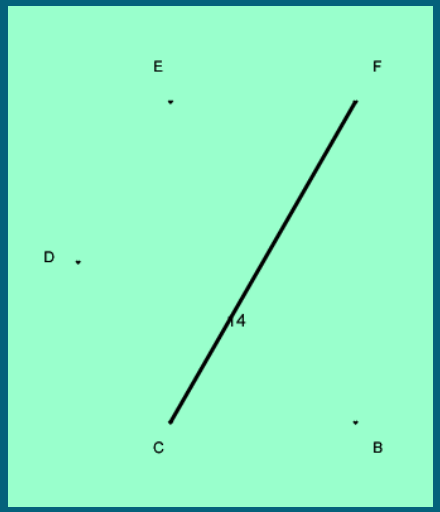


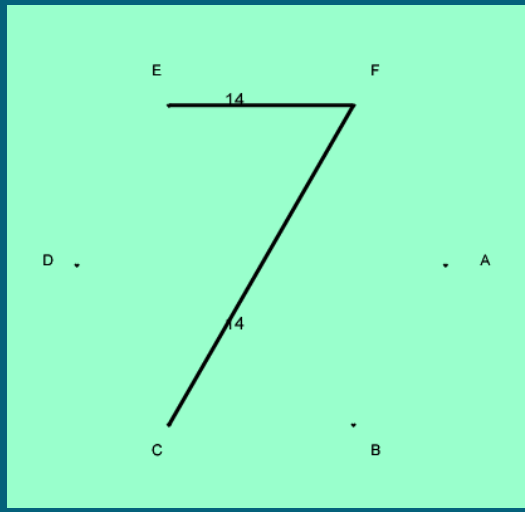
Elementary Graph theory – testing the algorithm

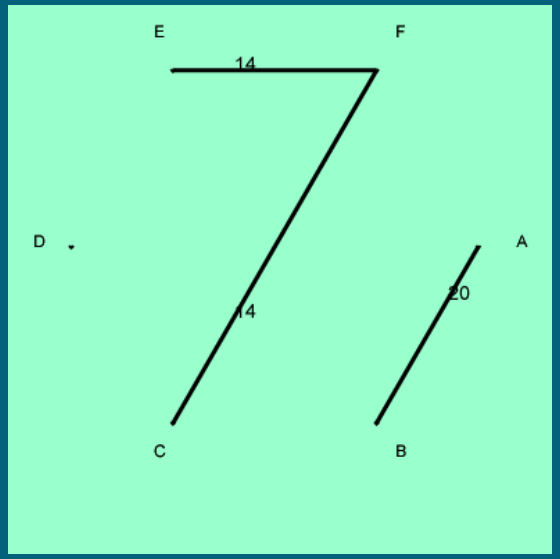


In case you cannot read the weights on the graph, please use the Network Matrix below.

	A	B	C	D	E	F
A	---	20	---	23	---	26
B	20	---	22	---	---	25
C	---	22	---	21	16	14
D	23	---	21	---	27	28
E	---	---	16	27	---	14
F	26	25	14	28	14	---







- etc

A statistics question linked to Excel

Drop into Excel

The ranks of data x_i and y_i are given in the following table. Calculate the Spearman rank correlation coefficient (S.R.C.C.), r_s?

Rank of x_i	1	2	3	4	5	6	7	8
Rank of y_i	2	3	6	4	1	8	7	5

Data table

Hand calculation or not

Give your answer to 4 decimal places and include the negative sign where necessary.

$r_s =$

A statistics question - tables or formula?

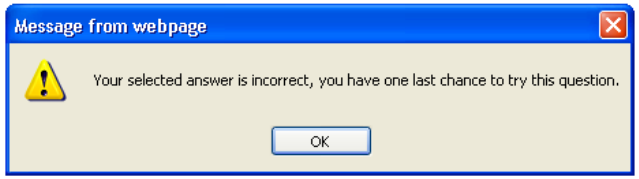
Statistics\Distributions\Binomial\Cumulative probability\Decontextual\by formula or 4dp tables

From the Cumulative Binomial distribution table below find and click the probability stated below, where X follows a binomial distribution and has the given value of n. The table below provides corresponding probabilities for ***X*** less than or equal to stated values of ***x***.

You can choose your answer from the Binomial distribution table by clicking your mouse. You will not be able to change your mind after you click on an answer, so make sure you choose your answers carefully before clicking. This question holds 2 marks, where full marks can be achieved by selecting the correct answer at the first attempt.

n= 20

Table



$P(X \leq 10 | p = 0.25)$ has the value of (click on the table)

P=	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5
n=5,x=0	0.7738	0.5905	0.4437	0.3277	0.2373	0.1681	0.116	0.0778	0.0503	0.0312
1	0.9774	0.9185	0.8352	0.7373	0.6328	0.5282	0.4284	0.337	0.2562	0.1875
2	0.9988	0.9914	0.9734	0.9421	0.8965	0.8369	0.7648	0.6826	0.5931	0.5
3	1	0.9995	0.9978	0.9933	0.9844	0.9692	0.946	0.913	0.8688	0.8125
4	1	1	0.9999	0.9997	0.999	0.9976	0.9947	0.9898	0.9815	0.9688
n=10,x=0	0.5987	0.3487	0.1969	0.1074	0.0563	0.0282	0.0135	0.006	0.0025	0.0025
1	0.9139	0.7361	0.5443	0.3758	0.244	0.1493	0.086	0.0464	0.0233	0.0233
2	0.9885	0.9298	0.8202	0.6778	0.5256	0.3828	0.2616	0.1673	0.0996	0.0996
3	0.999	0.9872	0.95	0.8791	0.7759	0.6496	0.5138	0.3823	0.266	0.266

WI question – proof reading

- In the following sentence, Ji has made at least one error. Fully correct each word (possibly including an apostrophe or a hyphen) in the sentence and press SUBMIT. Generated from one question – categories?
- Faith schools are inconpatible with the aspiration of inclusion in the state supported education secter.
  - Faith schools are incompatable with the aspiration of inclusion in the state-supported education secter.
- Sustainability promisses much but it signifyes nothing without a coherrent sett of actions. (badgers!)
- Successful study is only possable if you are properly organised and very determine. (UK/US English and grammar)
- Very hard – even if Word is available (but usually turned off)

Have I wasted the last 10 years?

What do the students think about it? (PERCEPTION/SOFT DATA)

-No stress – allows repeated practice

-***'How are we supposed to learn this without feedback?'*** – irate student!

-They query the feedback – there are errors (<0.1% rate)

-*'This provides a link between me and the lecturer.'* – not expected!

The ability to change the colour scheme really does help. I actually use different colours for different modules which helps to jog my memory. It also helps with the symptoms of visual stress. The words are less blurred, the characters sit straight on the line, nothing appears to move and the "rivers" that run through the text are much less noticeable.

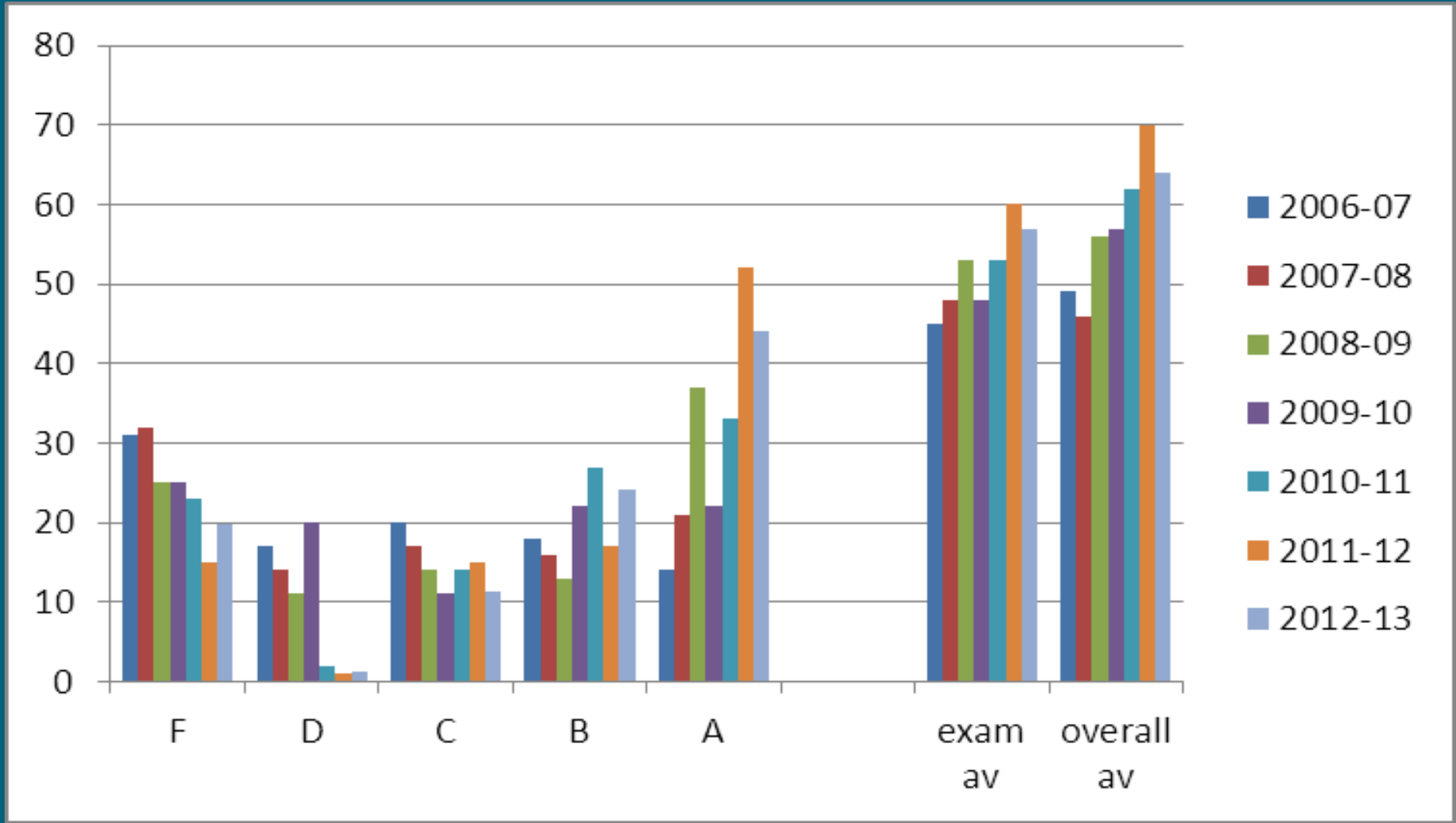
Wasted last 10 years (cont)

- What does it do to their learning? (ACTUALITY/HARD DATA)
- - answer file analysis (facility, discrimination, mal-rules metadata)
- - exam script analysis (indicators, marks profiles, failure rates)

Year-on-year results

(CAA 2008/9 onwards: % in grade/% mark)

NB: almost ALL resitters pass in August – evidence of continued use of CAA over the summer



This is a success in anybody's book but the main problems for Maths are:

- Systems cannot talk to each other (or the VLE)
- Difficult to understand thousands of answer files without a TAXONOMY OF ERRORS
  - Understanding errors could lead to better mal-rules for CAA, teaching material & teaching itself
- Hard to write new questions still
- Question discrimination should inform us more.

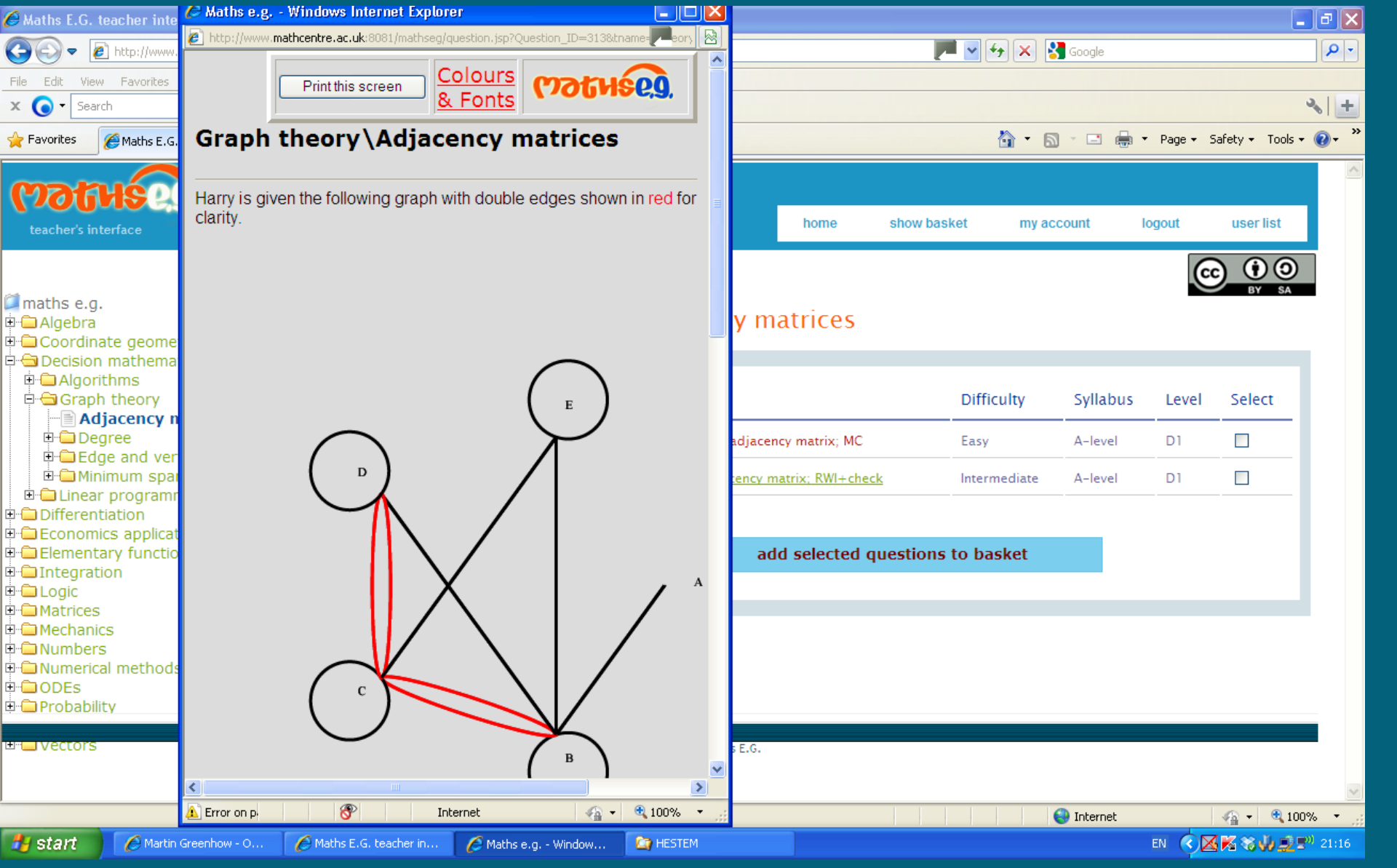
mathseg

maths e.g.
- Algebra
  - Adding polynomials
  - Algebraic fractions
  - Complete the square
  - Dimensional analysis
  - Expanding brackets
  - Factorisation
  - Indices
  - Linear equations
  - Modelling
  - Pascals Triangle
  - Proportionality
  - Quadratic equations
  - Rearranging equations
  - Roots & factors of polynomials
  - Simultaneous equations
  - Summations
  - Terminology
  - Understanding expressions
  - Algebric functions
- Differentiation
- Integration
- Matrices
- Numbers

Questions in topic and Related material

1	ma+nb=0; m,n +ve MC
2	inferences for Q=-R^n+S^m given equation; 4TFUSP
3	inferences for Q=-R^n-S^m given equation; 4TFUSP
4	inferences for Q=k*R^n/S^m; 4TFUSP
5	inferences for Q=k*R^n/S^m given equation; 4TFUSP
6	inferences for Q=R^n+S^m given equation; 4TFUSP
7	inferences for Q=R^n-S^m given equation; 4TFUSP
8	ma*nb=0; m,n +ve MC

Teacher interface – shop on Amazon?



Is it useful?

7000 hits in June

2nd most popular MathCentre resource

460 signed up teachers/lecturers

I could be famous … so tell all your colleagues, friends and relations, school teachers and lecturers you know, blokes you meet down the pub, women on the bus etc

Conclusions

- Javascript, MathML and SVG provide a rich environment for setting objective questions
- Positive effects on students' perceptions and on exam performances
- Widely-applicable database of questions
- Try **maths e.g.** at:

  http://www.mathcentre.ac.uk:8081/mathseg/

http://www.mathcentre.ac.uk:8081/mathsegteacher/

works on all browsers, not mobile devices(yet), link to VLEs

- The technology and much of the pedagogy is nothing to do with maths – this will work in other areas that can be made objective (e.g. phonics) … although we all need maths!

New project – *Get ready for Uni*

- Interactive web page based on Study Skills site
- http://www.brunel.ac.uk/~mastmmg/ssguide/sshome.htm