Kingston University London

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Numbas@KU

Using Numbas for formative and summative assessment

Replacing paper-based short tests with electronic assessment in a first year Linear Algebra module.

Introduction

Numbas@KU

- HESTEM practice transfer project
- Numbas gave us
  - maths e-assessment platform for formative tests that integrates with Blackboard (SCORM)
  - pre-existing questions suitable for 1st year modules
  - good usability and accessibility for students *and* staff

What we wanted to change

- Linear Algebra
  - 1-semester module (15 credits)
  - 5 paper-based, MCQ-style short tests designed to reward continuous engagement with 4% module mark each
  - + two 15% courseworks and a 50% exam
- In 2012/13 use eAssessment for formative “practice” *and* small summative assessments (short tests)

How we did it

- Rewriting paper-based questions for Numbas
  - Code!
    - Learning curve
  - Copying pre-existing questions from Newcastle
    - Easy!
- In total:
  - 22 paper-based questions into Numbas
  - 2 existing sophisticated Numbas questions from NCL
  - and one Pearson MyMathLab-based test for convenience
- Tested with disabled & dyslexic students beforehand

From paper-based questions…

The following matrices will be used throughout questions 1-7

$$A=\begin{pmatrix}1 & -2\\ 2 & 3\end{pmatrix},\ B=\begin{pmatrix}4 & 1 & 0\\ 2 & 0 & 3\end{pmatrix},\ C=\begin{pmatrix}2 & -3 & 4\\ 2 & 0 & -5\end{pmatrix},\ D=\begin{pmatrix}0 & 2 & 4\\ 2 & 1 & -1\\ 3 & 0 & -1\end{pmatrix},\ E=\begin{pmatrix}4\\ 3\\ 0\end{pmatrix},\ F=\begin{pmatrix}2 & -1 & 2\end{pmatrix}$$

1. Consider the following matrix arithmetic operations (do not carry out the operations):

(a) $A+B$ (b) $B+C$ (c) $C+D$ (d) $D-B$ (e) $E-C$ (f) $E+F$ (g) $F-E$

Which of the following statements is **entirely** true:

A: $E-C$ and $E+F$ are both possible but $F-G$ is not possible

B: $A+B$ and $B+C$ are both possible but $C+D$ is not possible

C: $B+C$ is possible but both $D-B$ and $E+F$ are not possible

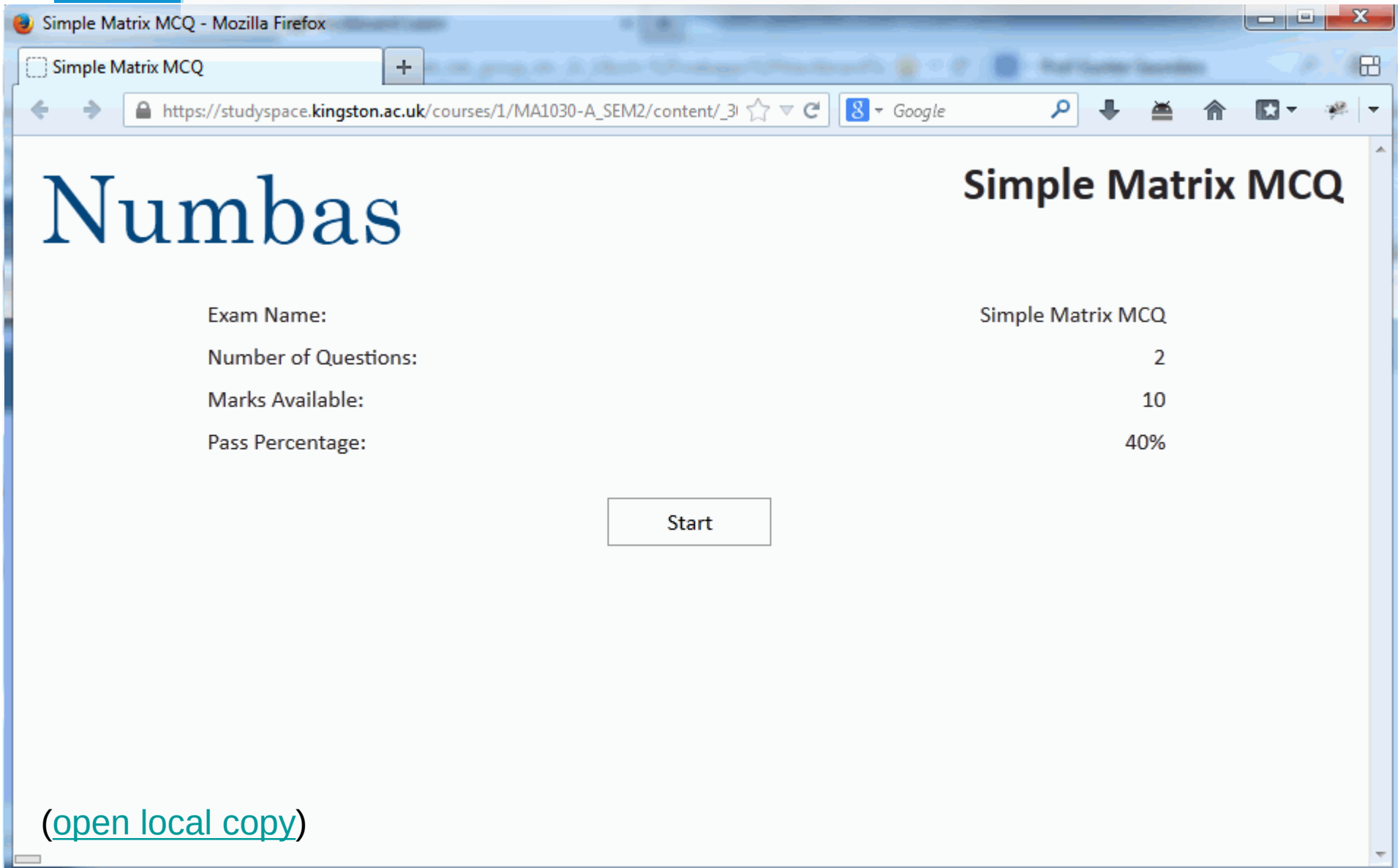
D: None of the matrix arithmetic operations in (a) to (g) above is possible

E: All of the matrix arithmetic operations in (a) to (g) above are possible

(1 mark)

(example PDF)

… to eAssessment



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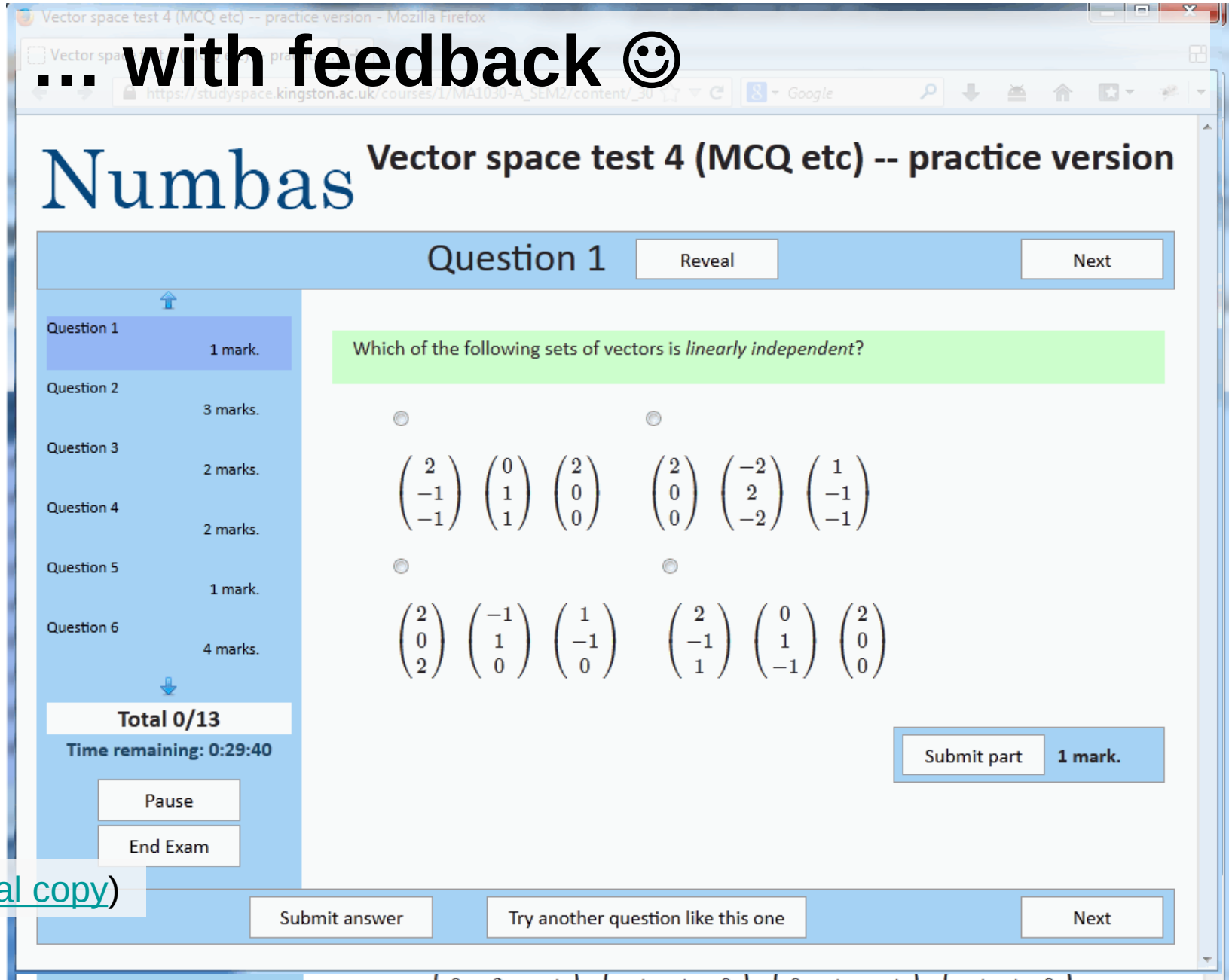
… with feedback ☺



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Implementation

- Blackboard integration (SCORM)
- Practice tests – formative (1 week)
  - Random parameters hopefully means students "**learn the method**" rather than "**learning the question**"
- Summative tests – 10 to 30 minutes
  - Accessibility considerations

Hopefully “learning the method”

Solve the system of equations using Gauss Elimination

Now write down the entries of the matrix you will use for Gaussian Elimination, remember to include the constants as the las

Now write down the entries of the matrix you will use for Gaussian Elimination, remember to include the constants as the last column.

$$\left(\begin{array}{ccc|c} 1 \checkmark & 1 \times & 1 \times & 1 \checkmark \\ 1 \times & 1 \times & 1 \times & 1 \times \\ 1 \times & 1 \times & 1 \checkmark & 1 \checkmark \end{array}\right)$$

Score: 0.4/2.2

Show feedback

back

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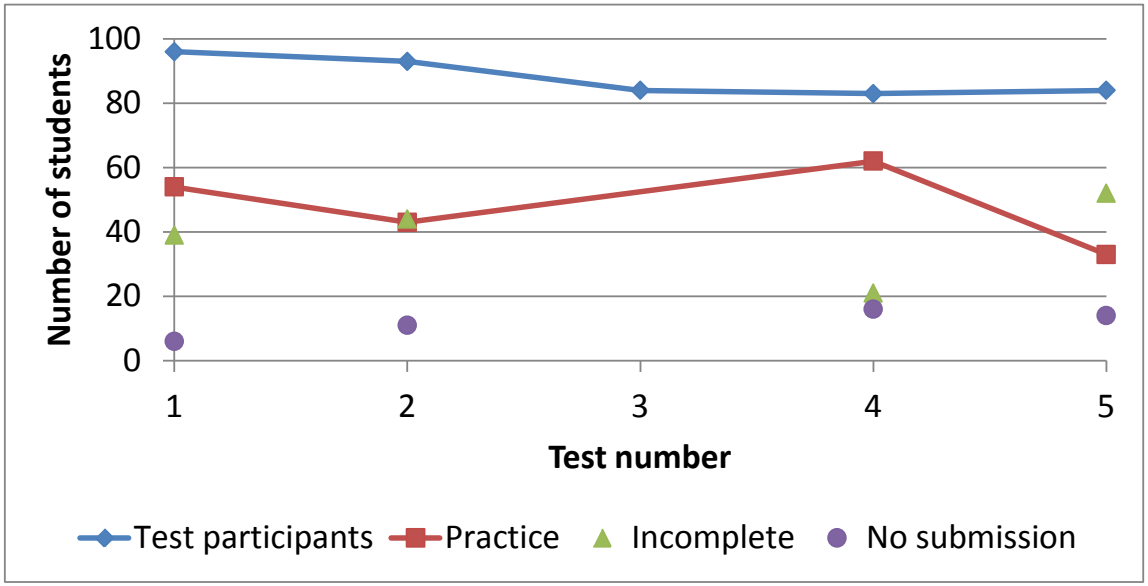
Your answer is incorrect.

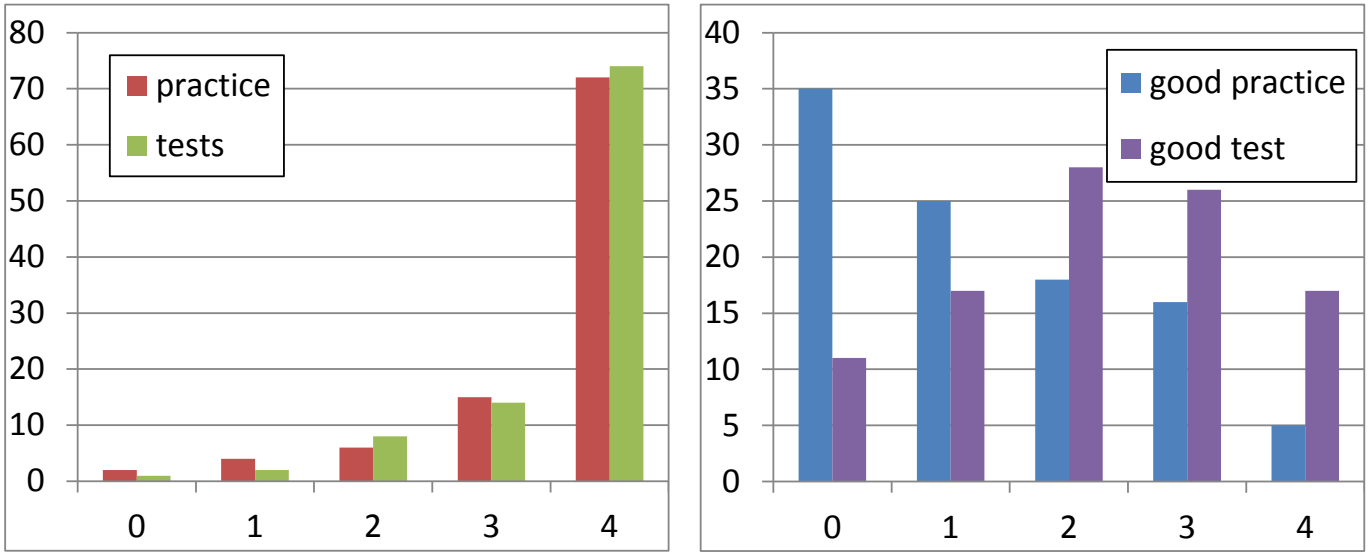
Gap 2

What happened



- Formative participation is "Practice" + "Incomplete" is 84% to 94%
- "No (practice) submission" ≤ 16%

How many students did 0,1,2,3,4 tests?

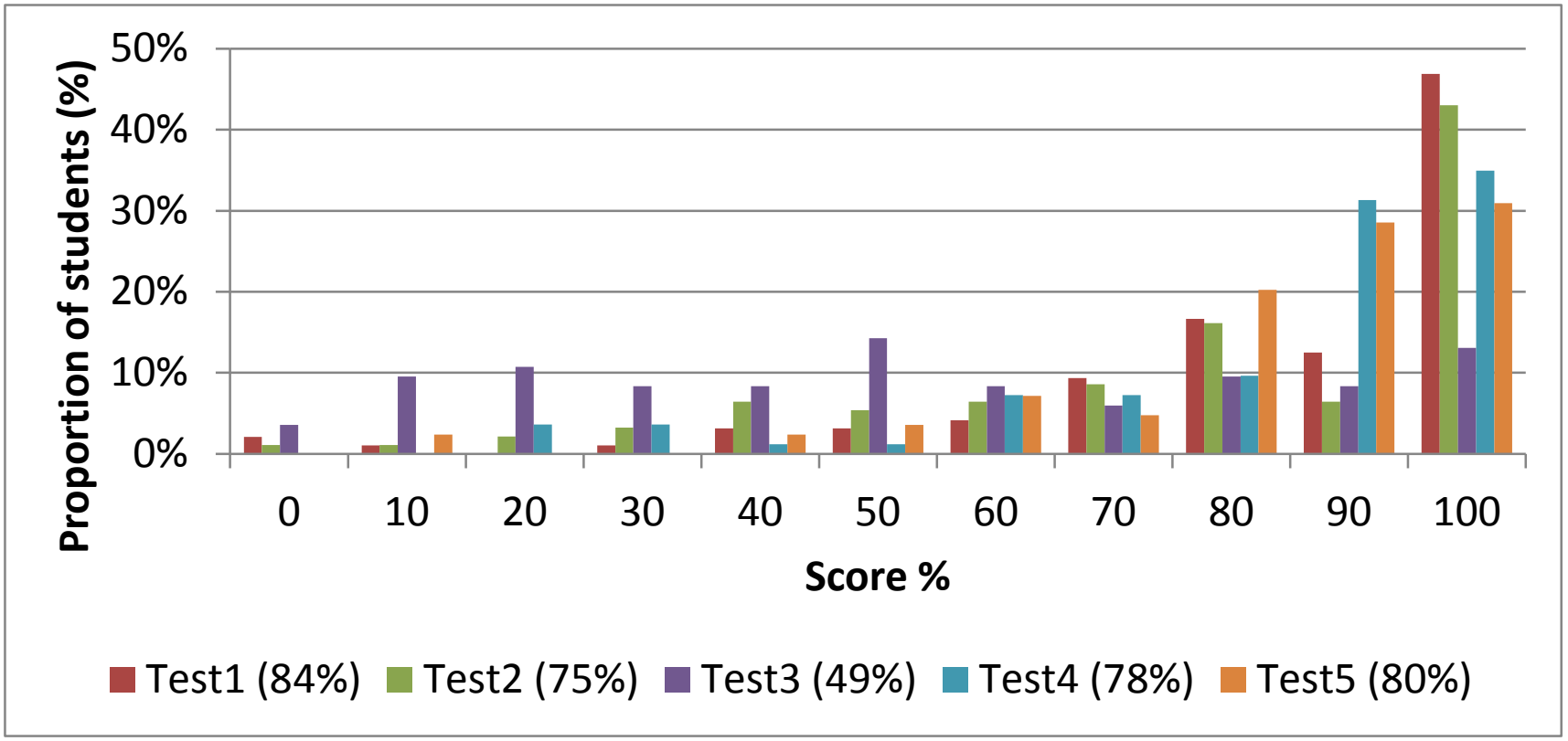


- “Good” = “greater than the mean”
- Few students did 4 “good” practice tests (“No submission” again)

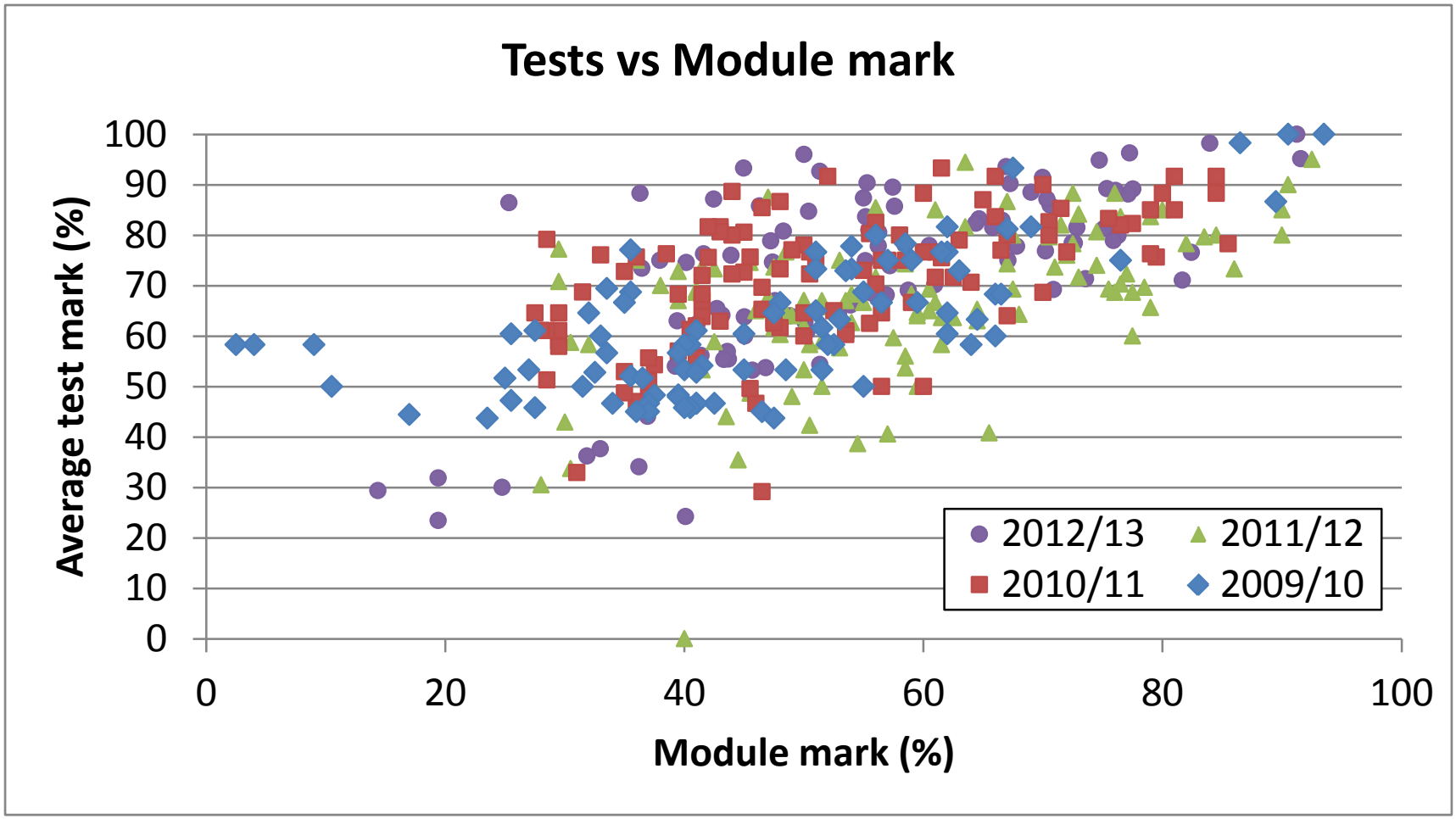
Satisfaction? End of module survey

- If you did the quizzes, how did you feel about them?
  - They were useful and helped me with the weekly exercises. 53.846%
  - They were useful and helped me to revise for the in-class tests. 61.538%
  - They were useful and helped me understand the material but didn't directly help with the work. 34.615%
  - They were unhelpful. 0%
  - They were unhelpful as they seemed unrelated to the work we were doing. 0%
  - What quizzes? I didn't know about them... 0%

Results: Test marks distribution



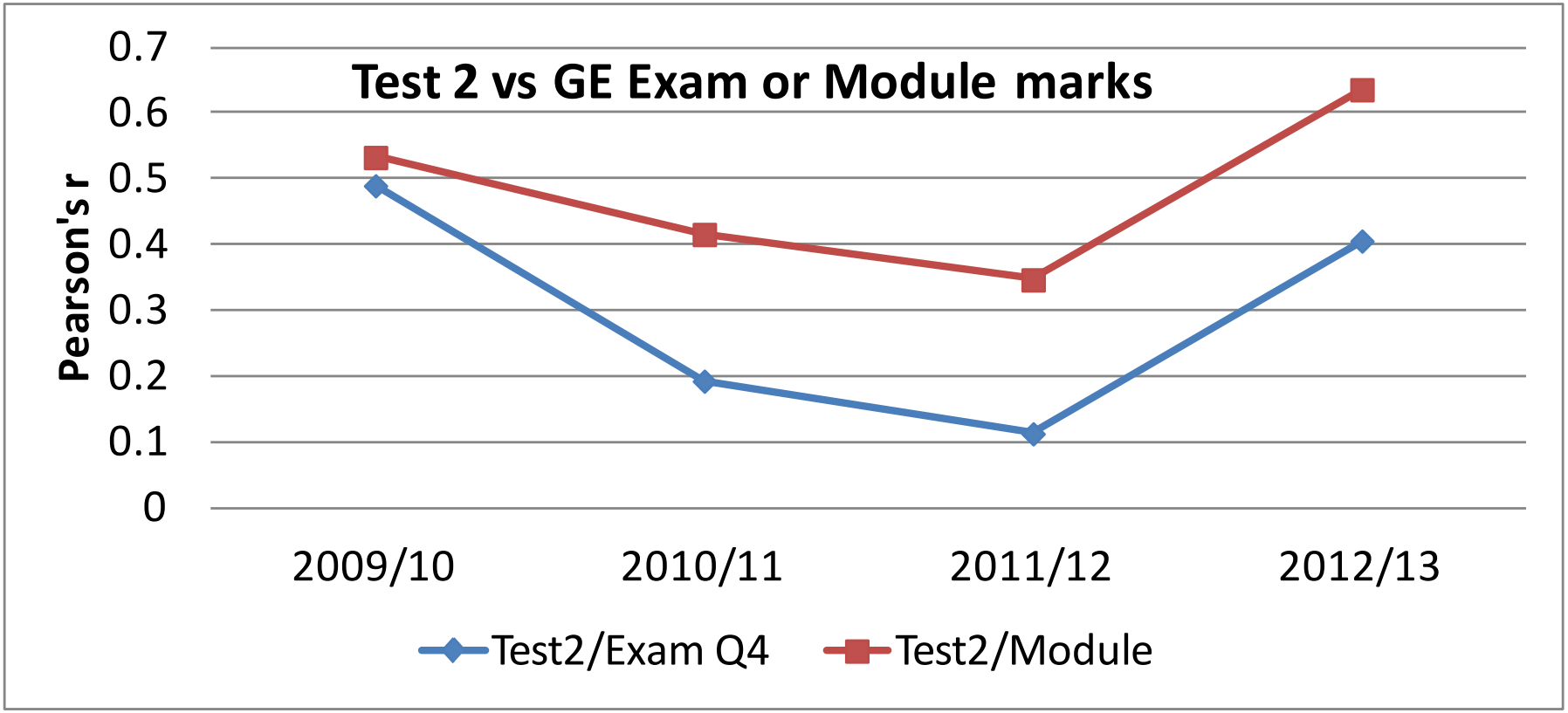
Results: Tests *vs* Module mark



Correlation?

- There is a correlation between the test scores and final marks r≈0.5-0.7 (it's worth 20%!)
- Drilling-down, Gaussian Elimination is historically a discriminating topic, tested in "Test 2" with Numbas and the final exam
- We hope there is no negative impact of eAssessment and that there might be a positive one relating "practice" to mastery.

No negative impact



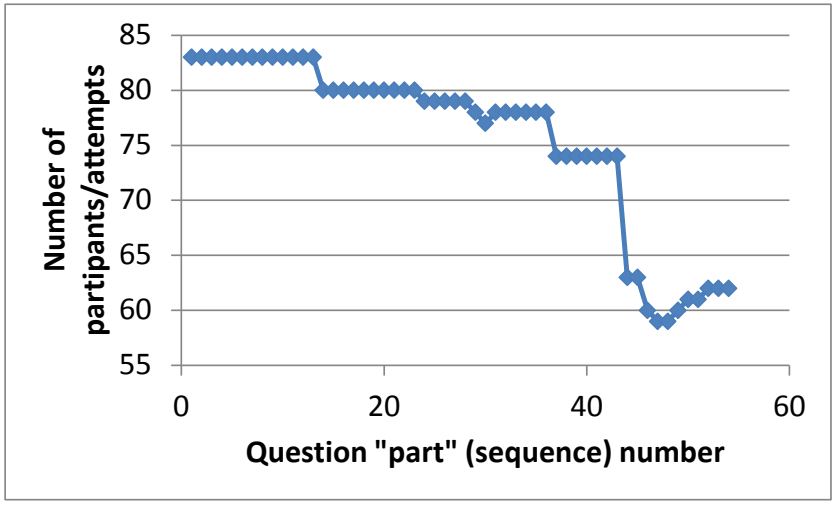
“Learning” Gaussian Elimination?

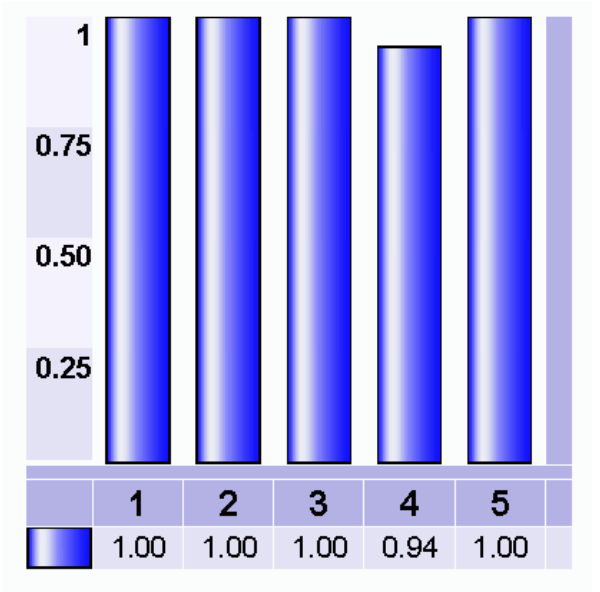
			Exam Q4		
			F	M	P
Test 2 by Year	2009/10	F	30	15	19
		M	8	6	2
		P	10	7	27
	2010/11	F	20	26	14
		M	8	13	4
		P	13	14	22
	2011/12	F	20	25	15
		M	3	5	3
		P	19	11	24
	2012/13	F	20	18	11
		M	4	1	0
		P	15	7	26

- Association between pass/fail/missing practice in the GE tests and the GE exam question is statistically-significant in 2009/10 and 2012/13 but not in 2010/11 & 2011/12

Question quality/difficulty

- Gaussian elimination & matrix inverse:
  - 54 entries
  - Student attempts drop-off towards the end of “parts”





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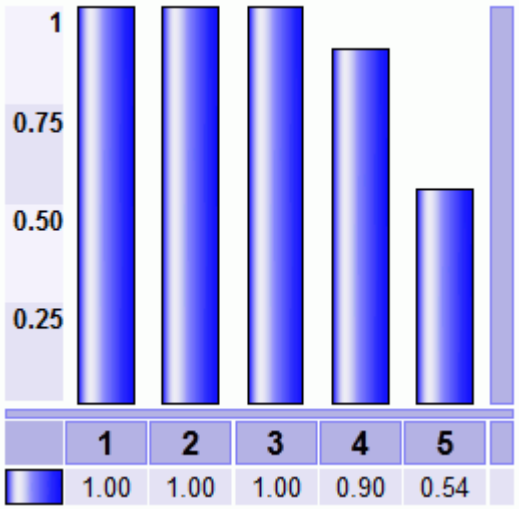
Question quality/difficulty

Which of the followin

- $\begin{pmatrix}1\\-1\\0\end{pmatrix}$ $\begin{pmatrix}1\\-1\\2\end{pmatrix}$
- $\begin{pmatrix}2\\-2\\2\end{pmatrix}$ $\begin{pmatrix}-2\\-2\\0\end{pmatrix}$ $\begin{pmatrix}0\\0\\1\end{pmatrix}$ $\begin{pmatrix}0\\-2\\1\end{pmatrix}$ $\begin{pmatrix}2\\0\\1\end{pmatrix}$ $\begin{pmatrix}2\\-2\\2\end{pmatrix}$

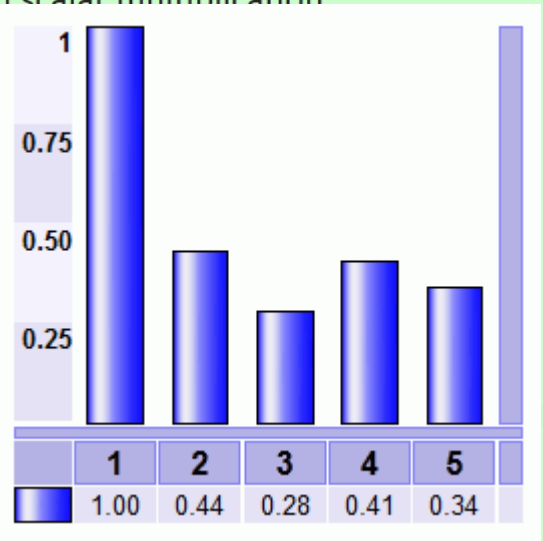
- Average mark=89%
- Best 60% of students: all 100% correct
- Discriminates smoothly
- a bit easy ;-)



1 mark.

Question quality/difficulty

- Average mark=50%
- Best 20% of students: 100% correct
- The rest: 30-50% correct
- Discriminates but not smoothly.



$\mathbb{R}^3$ is a vector space under the usual definition of vector addition and scalar multiplication.

Consider the three subspace axioms:

1. $\underline{0} \in V$
2. $\underline{v} + \underline{w} \in V$
3. $k\underline{v} \in V$

$\forall \underline{v}, \underline{w} \in V$ and $k \in \mathbb{R}$.

For each of the following sets, if V is not a subspace of $\mathbb{R}^3$ select the axiom it fails to satisfy. If V is a subspace, select the final option.

(**NB**: These are "multiple response" questions where 1 or more options might be correct.)

a)

V is the set of vectors $(a, b, c)^T$ where $c = 0 \quad 0 \quad ^2 \leq 4$

- $\underline{0} \notin V$
- $\underline{v} + \underline{w} \notin V$ for some $\underline{v}, \underline{w} \in V$
- $k\underline{v} \notin V$ for some $\underline{v} \in V$ or $k \in \mathbb{R}$
- None of these (V is a subspace)

1 mark.

Next Steps

- Work on encouraging completion of practice tests.
- Consider ways to encourage paper working-out (students seem to stick in “modes”) – interesting research question?

Findings, conclusions and recommendations

- Numbas works ☺
  - Formative (and low-stakes summative)
- It can be quite accessible
- As always with eAssessment
  - Be prepared for a learning curve
  - Get another set of eyes to test questions *and* their deployed versions
  - Evaluate questions afterwards

Any questions?

- With thanks to
  - Bill Foster, Christian Perfect, Anthony Youd from Newcastle University
  - Michael Grove from Birmingham University