Developing Standardised Tests of Post-Primary Students' Mathematical Knowledge in the Context of the Implementation of Project Maths

Seán Close, Gerry Shiel, Joanne Kiniry & David Millar

Educational Research Centre

St Patrick's College, Drumcondra, Dublin 9

Introduction

This presentation briefly describes the results of three pilot studies carried out in the Spring and Autumn of 2011 and in the Spring of 2012. The pilot studies are part of a project to develop a standardised mathematics test for use in the Second year of post-primary school which would be compatible with the incoming Project Maths curriculum for Junior Cycle.

Project Maths

- Project Maths initiated in post-primary schools in 2008

- Being phased in over an eight-year period

- Commenced with 24 (now 23) pilot schools in September 2008

- To be fully implemented, across all classes, by June 2015

- Greater emphasis on understanding of mathematical concepts, with increased use of contexts and applications and development of problem-solving skill

- Reflects a move towards Realistic Mathematics Education

- PISA 2012 provides an opportunity to compare the performance of PM pilot schools with non-pilot schools.

Need For Standardised Tests At Junior Cycle

The decision to develop a new standardised test of mathematics at Junior Cycle Level was motivated by several factors:

1. Outcomes of a study commissioned by the NCCA, that established a need for standardised tests of mathematics (and reading) at lower secondary level, and pointed to the potential diagnostic value of such tests for parents, teachers and students (Shiel, Kellaghan & Moran, 2010).

2. A proposal in the DES' *National Strategy to Improve Literacy and Numeracy in Schools* (DES, 2011) that post-primary schools administer standardised tests in mathematics (and reading) to students at the end of 2nd year and use outcomes for school self-evaluation and improvement.

Item Classification for 1st Pilot Study Test

Content Strand:	**No. of Items**
Statistics & Probability	27
Geometry & Trigonometry	15
Number & Measure	30
Algebra & Functions	23
Total	**95**
Skill Category:	
Recall facts & terms; Implement procedures	28
Reason & connect; Apply, analyse & solve problems	67
Total	**95**
Context Category:	
Practical Contexts	67
Mathematical Contexts	28
Total	**95**
Item Format: (No partial credit items)	
Multiple Choice	19
Open Response	76
Total	**95**

Results of 1st Pilot Study

•1026 students in 10 schools (including 5 DEIS schools) participated in the 1st pilot study.

•The mean weighted item percentage scores on the three test booklets were:

Booklet 1 (33 items) - 37% (N = 352); 28% in DEIS schools

Booklet 2 (32 items) - 44% (N = 340) ; 28% in DEIS schools

Booklet 3 (31 items) - 41% (N = 334) ; 27% in DEIS schools

Figures considered low for a potential standardised test.

Numbers of Items with Serious Problems by Booklet: 1st Pilot Study

	Number of Items with Problems*			
	Total Number of Items	Difficulty < 0.25 Only	Point Biserial <0.30 Only	Below criterion for both
Booklet 1	33	8	1	3
Booklet 2	32	8	1	0
Booklet 3	31	7	2	0
All Booklets	96	23	4	3

*Criteria: Difficulty Level < .25; Point Biserial Coefficient < .30.

Item Classification for 2nd Pilot Study Test

Content Strand:	**No. of Items**	(1st Pilot)
Statistics & Probability	41	(27)
Geometry & Trigonometry	35	(15)
Number & Measure	41	(30)
Algebra & Functions	43	(23)
Total	**160**	**(95)**
Skill Category:		
Recall facts & terms; Implement procedures	93	(28)
Reason & connect; Apply, analyse & solve problems	67	(67)
Total	**160**	**(95)**
Context Category:		
Practical Contexts	96	(67)
Mathematical Contexts	64	(28)
Total	**160**	**(95)**
Item Format:		
Multiple Choice	160	(19)
Open Response	-	(76)
Total	**160**	**(95)**

RESULTS of 2nd Pilot Study

•1242 students in 20 schools (including 5 DEIS schools) participated in the 2nd pilot study.

•The mean weighted item percentage scores on the three test booklets were:

Booklet 4 (42 items) - 52% (N = 307) ; 51% in DEIS schools

Booklet 5 (36 items) - 45% (N = 312) ; 38% in DEIS schools

Booklet 6 (41 items) - 45% (N = 315) ; 38% in DEIS schools

Booklet 7 (41 items) - 48% (N = 318) ; 43% in DEIS schools

Numbers of Items with Problems by Booklet: 2nd Pilot Study

	Number of Items with Problems*			
	Total Number of Flagged Items	Difficulty < 0.20 Only	Point Biserial <0.25 Only	Below criterion for both
Booklet 4	13	1	10	2
Booklet 5	7	0	4	3
Booklet 6	12	2	8	2
Booklet 7	11	1	4	6
All Booklets	43	4	26	13

*Criteria: Difficulty Level < .25; Point Biserial Coefficient < .30.

Item Classification for 3rd Pilot Study Test*

		AH	BH	CH	AO	BO	CO	Link items	Total
Content	**Statistics & Prob.**	6	5	4	9	5	8	4	43
	Geometry & Trig.	8	6	4	2	6	1	4	31
	Number & Meas.	3	6	5	8	8	8	3	41
	Algebra & Function	7	7	11	5	5	7	5	47
	Total	24	24	24	24	24	24	16	**160**
Skill	**Recall & Impl.**	13	11	11	13	17	17	7	89
	Reas. & P.S.	11	13	13	11	7	7	9	71
	Total	24	24	24	24	24	24	16	**160**
Context	**Practical**	9	14	16	15	17	16	10	97
	Mathematical	15	10	8	9	7	8	6	63
	Total	24	24	24	24	24	24	16	**160**

*All multi-choice items. H = Higher Course; O = Ordinary Course

*H = Higher Course; O = Ordinary Course

Results of 3rd Pilot Study

Mean percentage correct by booklet and by test division*

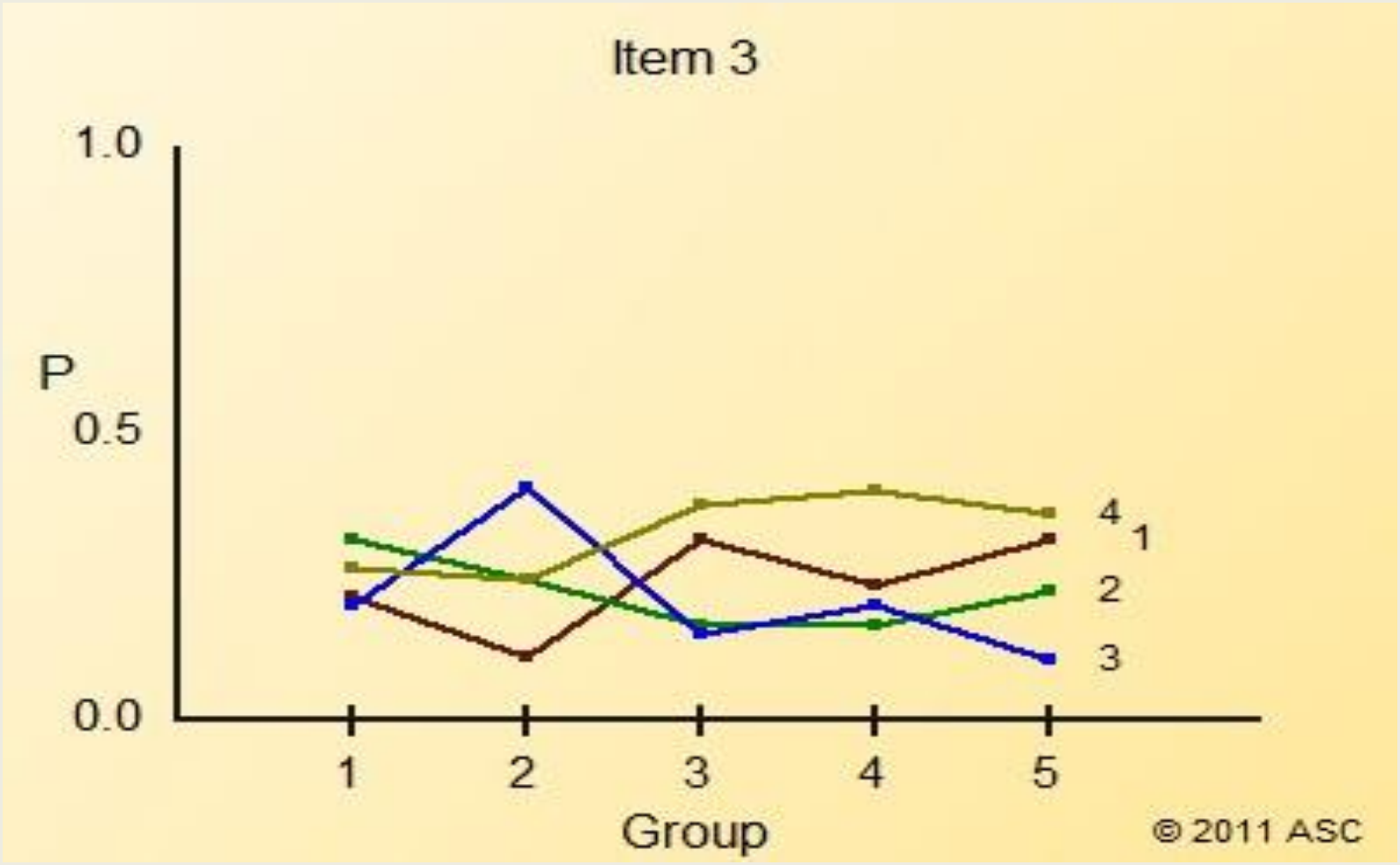
	AH (N = 341)	BH (N = 342)	CH (N = 351)	AO (N = 190)	BO (N = 192)	CO (N = 187)
Unique (24 items)	42	49	49	57	56	47
Common (16 items)	68	70	69	42	42	42
Combined (40 items)	53	57	57	51	50	45
Combined (DEIS)	43	48	46	43	47	42

litres of Water (G)	Number of Hours (H)
1,500	*0*
2,300	*1*
3,100	*2*
3,900	*3*
4,700	*4*
…….	…….

Q.3 Michelle is filling a small swimming pool with water. When she started there was already 1500 litres of water in the pool. The table shows the number of litres (L) in the pool after filling it for (H) hours. Which of these equations gives the number
of litres (L) of water in the pool after (H) hours?

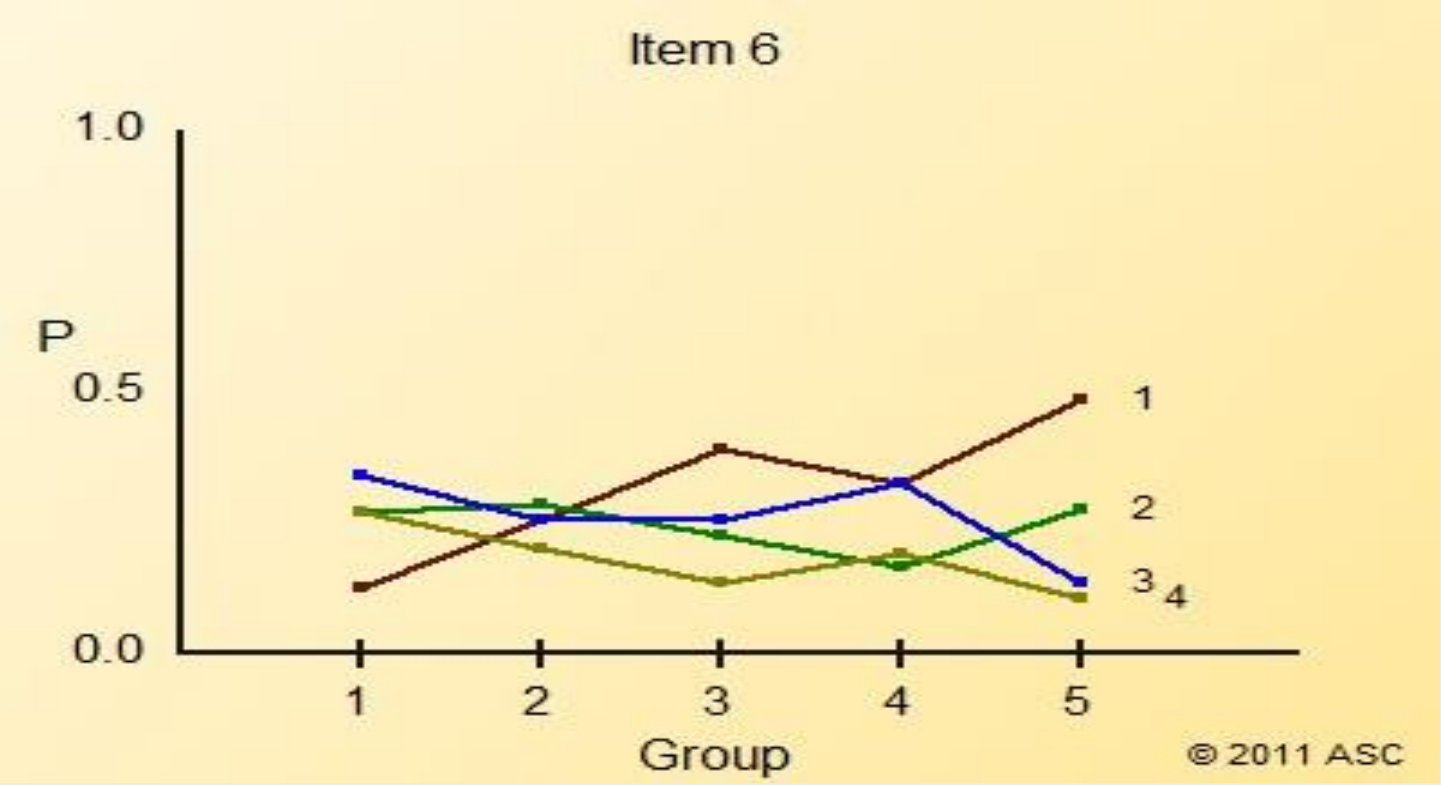
A. L = 700H (**23%**)
B. L = 1500H + 800 (**20%**)
C. L =1500H (**18%**)
D. L =1500 + 800H* (**31%**)

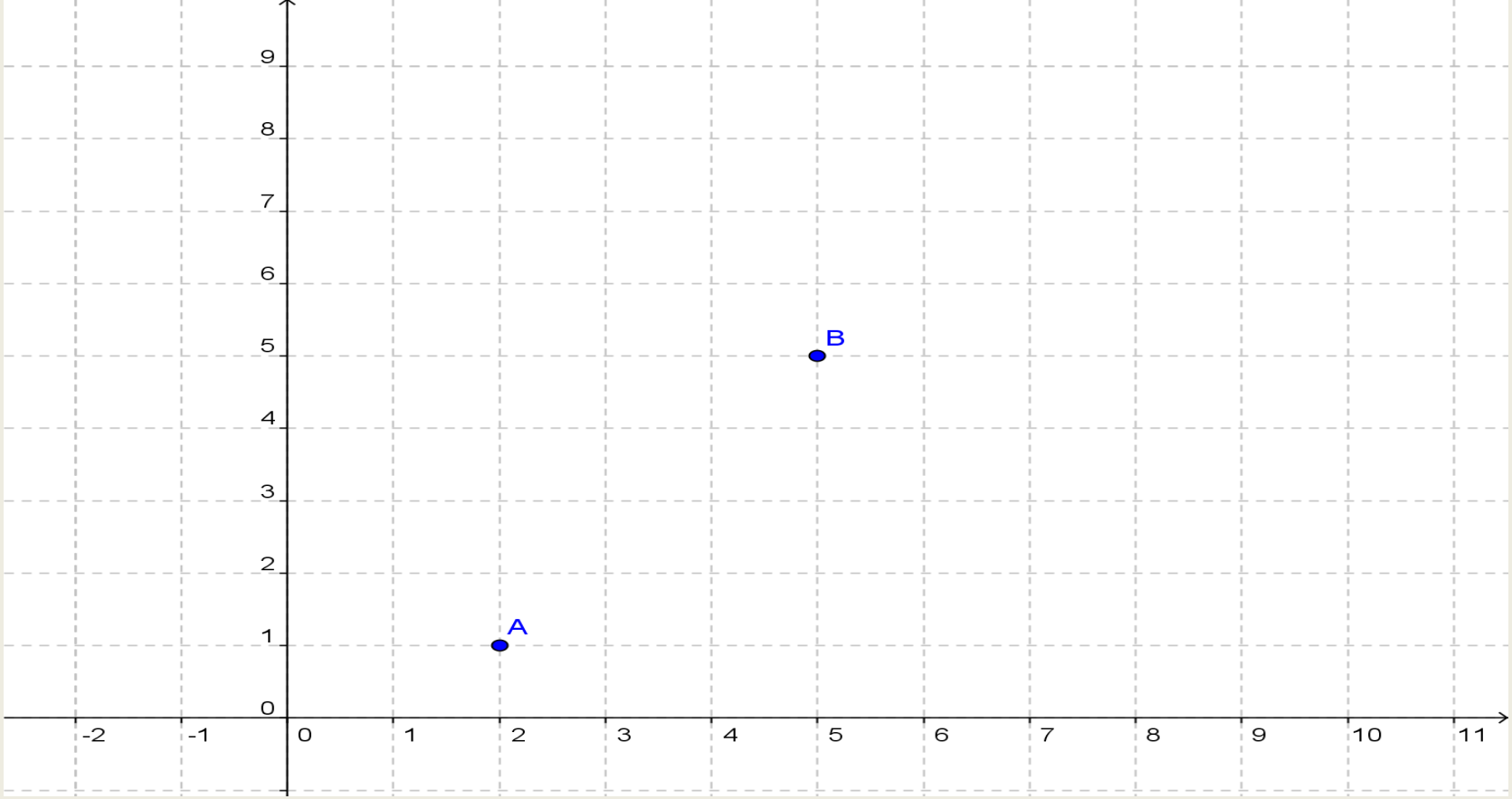
HL students: 31% correct .14 PB


Item 3
1.0
P
0.5
0.0
1
2
3
4
5
Group
4
1
2
3
© 2011 ASC

Q.6 Which of these are solutions for the equation $x^2 + 5x + 6 = 0$?

A. $x = -2, x = -3$ **(29%)**
B. $x = 2, x = -3$ **(21%)** **HL students: 29% correct .27 PB**
C. $x = 1, x = 6$ **(23%)**
D. $x = -1, x = -6$ **(16%)**



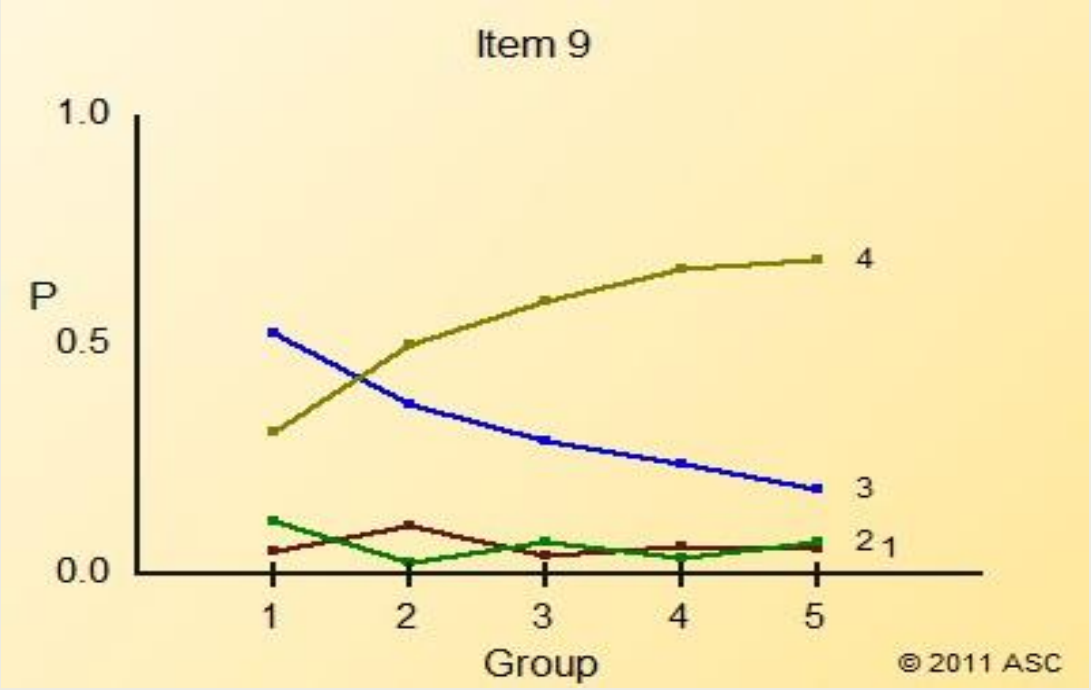


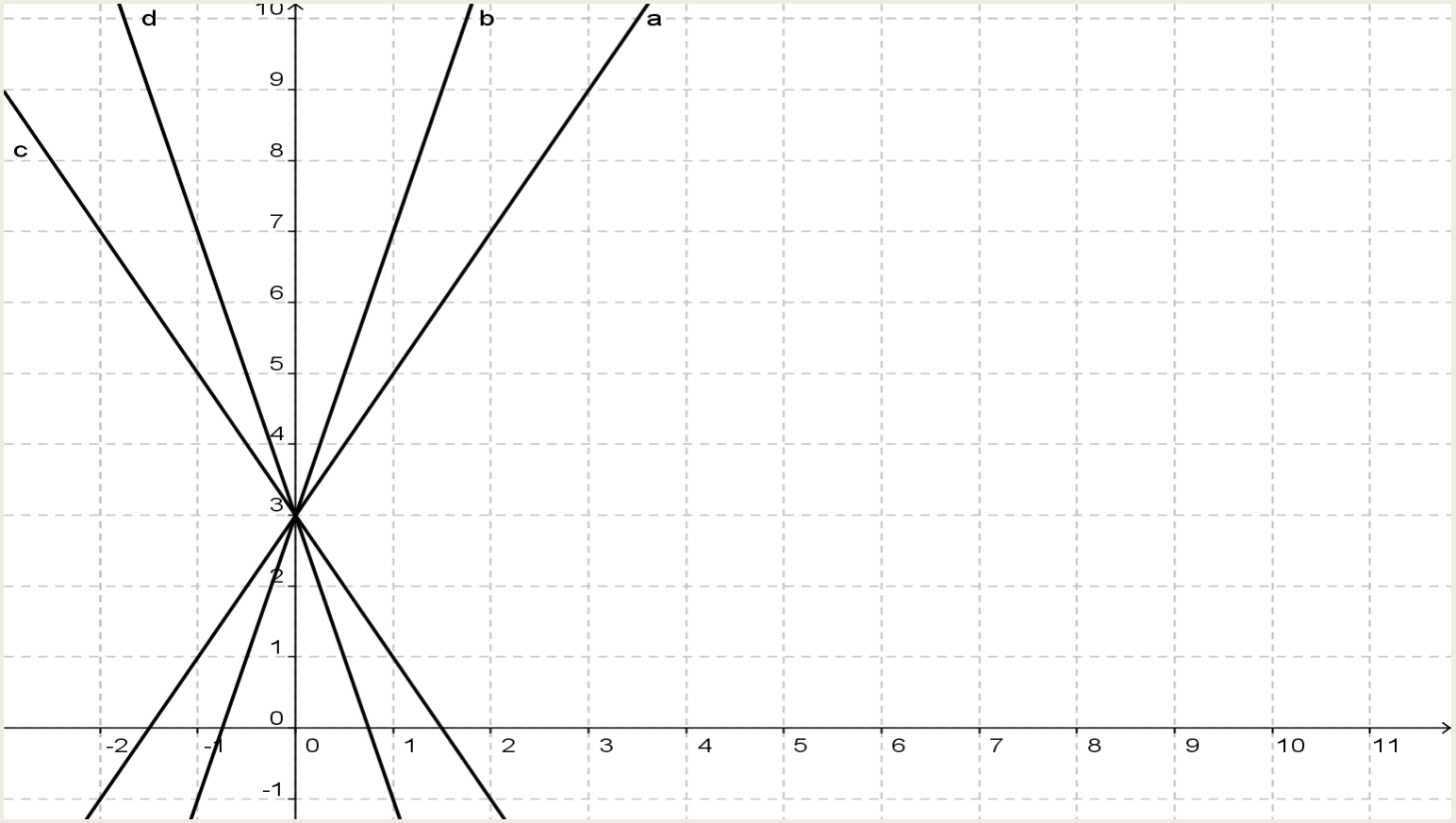
Q.9 What is the slope of the line joining the two points on the diagram above?

(A) $-\frac{4}{3}$ (B) $-\frac{3}{4}$ (C) $\frac{3}{4}$ (D) $\frac{4}{3}$

6% **6%** **29%** **54%**

HL students: 54% PB .28

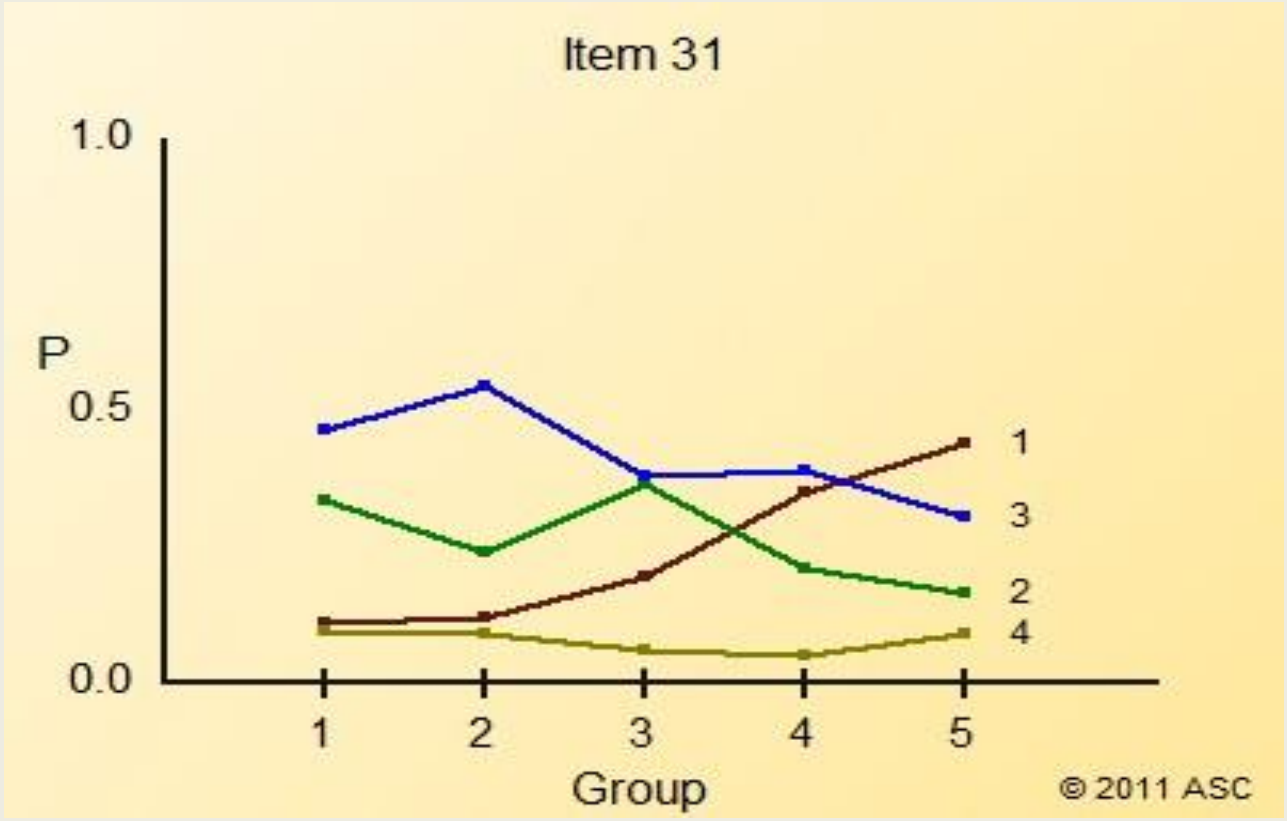

Item 9
1.0
P
0.5
0.0
4
3
2
1
1
2
3
4
5
Group
© 2011 ASC



Q.31 In the diagram below which of the four lines is the line y=2x + 3?

(A) Line a (**23%**) (B) Line b (**23%**) (C) Line c (**35%**) (D) Line d (**6%**)

HL students: 23% correct .29 PB


Item 31
1.0
P
0.5
0.0
1
2
3
4
5
Group
1
3
2
4
© 2011 ASC

Conclusions

•There is difficulty in developing standardised mathematics tests when a new PM syllabus is being implemented on a phased basis. An added complication in this regard is that there is no prescribed programme for Second year students in post-primary schools though there is one for First year students (DES/NCCA, 2010).

•The difficulty in developing a single standardised mathematics test for both Ordinary Level track and Higher Level track students (with the former being mainly concentrated in DEIS schools). As a result, two separate standardised tests for use in schools are being developed – a Higher level test and an Ordinary level test, with a subset of common linking items in both tests.

•There may be a need to increase the number of items that each student is asked to attempt, in order to improve reliability. Computer-based adaptive testing, if used, could help to deal with this issue, by targeting items more precisely to student ability levels. In such a case, there would be less need to distinguish between levels since students would be assigned items based on their performance on earlier items in the test