Three Steps Forward Two Steps Back

Innovation and implementation of e-assessment in high stakes mathematics tests for 14-19 year olds

The Future

Turn of the century high expectations of a technological revolution in high stakes assessment:

- 2002 QCA international seminar: *technologies will develop that may radically change the way in which we assess learners* [and] *have a positive impact on teaching.*
- 2004 Ken Boston predicted: *on screen assessment will shortly touch the life of every learner in this country.*

Predictions

- By 2010
- All new qualifications would include an option for on-screen assessment
- All exam. boards would allow students to submit coursework assignments electronically
- Most GCSE and A level exams would be available on-screen
- GCSEs would be offered on-demand

(Boston 2004)

The present: assessment

High stakes on-screen maths assessments available 2015	
Functional Skills levels 1 and 2	*Combination of short and longer answers*
City and Guilds principles of using English and Mathematics Entry 3	*30 marks: one number answers*
ACCA Foundation Level exams (and a handful of qualification papers)	*Multiple choice, multiple response, multiple response matching, number*
ATT (Taxation Technicians):	*60 MCQs*
AAT (Accounting Technicians)	*automatically marked*
Cambridge Progression Business Banking	*50 MCQs [withdrawn]*
End of primary times tables tests (from 2017)	

The present: marking

On-screen marking	
66% of GCSE and A level scripts marked on-screen (approximately 10million) (2013 figure)	*Reduction of clerical errors*
All subjects apart from performing/ expressive arts had some papers marked on screen	*More frequent and consistent monitoring of marking*
Just under 90% of maths papers marked on screen	*Increased marking reliability*
Overall: Pearson Edexcel 88%; OCR 79% AQA 60%; WJEC 13%	*Data analytics*
Item level marking (just under 50% in 2012)	
But reliability of marking for mathematics 'extremely high' (Newton, 1996) anyway (and see Benton 2015 : 'no evidence of moving components to marking on	

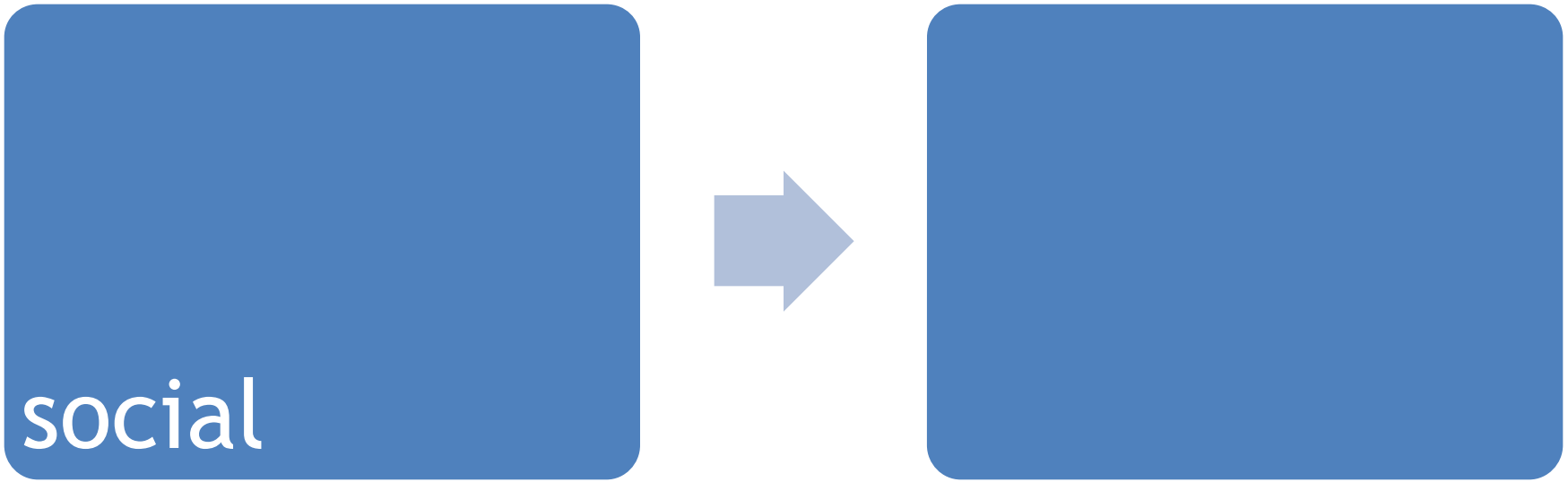
The present: other developments

Technological improvements in administration:

- Parcelforce Worldwide and the yellow labels
- Electronic examination entries – standard data formats
- Electronic release of results
- Requests for access arrangements and modified papers
- Examiner allocations
- E-portfolios

NB applies mainly to general qualifications…….

Why?



Regulation

Ofqual set up in April 2010 under the *Apprenticeship, Skills, Children and Learning Act* 2009 as a non-ministerial government department reporting directly to parliament.

Responsible for: *making sure that regulated qualifications **reliably** indicate the knowledge, skills and understanding students have demonstrated* [emphasis added]

Goal 1 for 2016-19: *regulate for the validity of general qualifications throughout their life-cycle*

Regulation

The regulatory environment:

- *We will not unduly prevent or discourage innovation save where innovation would threaten validity.* (Ofqual Corporate Plan 2015-18, March 2015)

- *Before setting a specified level of attainment for a qualification…..an Awarding Organisation must review the specified levels of attainment ……and must use the results…..to ensure that the specified level of attainment it sets …..will promote consistency.* (General Conditions of Recognition, September 2015, H3)

- *The arrangement of work stations and the position of the invigilator's desk **must** facilitate detection of any unauthorised activity by candidates, for example communication with others or use of unauthorised reference material.* (JCQ Instructions for conducting on-screen tests, 2015-2016, 6.3)

Social expectations

- Certainty about the role of maths as a:
- catch-all term for ‘numeracy’
- utilitarian skill
- facilitator to support entry to employment

Purpose of mathematics: historical

- 1494 Everything About Arithmetic, Geometry and Proportion, Luca Pacioli, intended to 'instruct businessmen'
- Growth and increasing complexity of English economy late 17th century led to demands for new services: 'schoolmasters who could instruct youths in mathematics, book-keeping and accountancy, calligraphy and surveying' *(Holmes, 1982)*
- Mathematics [introduced by the 1870 Education Act] consisted entirely of arithmetic with an emphasis on the skills needed in a shop or bank (*Living heritage: going to school)*
- Demand for the subject is social and industrial not educational. [In the 8th year]he should learn to apply [algebra] to the more complicated problems of business, banking, investments etc. (*Myers, pedagogy of Elementary mathematics, 1902)*
- Cold Warriors wanted High Schools to expand the number and rigour of science and mathematics courses in order to prepare students to major in engineering and physics in college. *(Ryan and Schlup, Historical Dictionary of the 1940s)*
- Then there is the concern about the standards of numeracy of school-leavers. Is there not a case for a professional review of the mathematics needed by industry at different levels? *(Callaghan, Ruskin College, 1976)*

Purpose of mathematics: historical

- Too much time is spent on non-essentials – study of definitions, surds, divisions by a trinomial, simultaneous equations, simplification of algebraic forms. Spend more time on simple fundamentals – logarithms, elements of trigonometry, a wee bit of analytics and a taste of the calculus. (D.E Smith, to maths conference in Greensboro, N. Carolina, 1918.)

Purpose of mathematics: historical

- London Chamber of Commerce Mathematics Examination: Senior Commercial Certificate May 1909
- If money be worth 4 per cent. per annum what should be paid now for an annuity of £1 payable at the end of one year, £2 the next year, £3 the next year and so on indefinitely?
- A merchant holding a stock of wine of between 180 and 200 dozen bottles sold it to A and B. A lost 1/8th of his share by breakage in transit and B lost 5% from a similar cause. If each then had the same number of bottles, determine the possible amounts of the original stock.

Purpose of mathematics: current

- Good levels of English and Mathematics continue to be the most generally useful and valuable vocational skills on offer. (Wolf Report, 2011)
- The Employment Equation: Why our young people need more maths for todays jobs (Sutton Trust 2013) ‘For young people from less affluent backgrounds in particular their ability to……play a productive role in the workforce will depend on their mathematical competence.’
- …all adults in the workplace benefit from having sufficient mathematical understanding to spot errors, make quick estimations and employ basic mathematical concepts such as sequences, probability and statistics. (Post-16 Skills Plan, DfE and DBIS, July 2016)
- GCSE specifications in mathematics should encourage students to develop confidence in, and a positive attitude towards, mathematics and to recognise the importance of mathematics in their own lives and to society. (Subject content and assessment objectives)

Case studies

One nurse…..described how she calculated the volume of liquid (2.4ml) required for 120mg dose of amakacine. ‘I knew the doses …I knew that that one is two point four…..two point four mils. With the amakacine, whatever the dose is, if you just double the dose, it’s what the mils is. Don’t ask me how it works, but it does’.

Tom [an accountant responsible for UK bank audits] did not solve equations algebraically but used trial and error.

The Employment Equation: Why our young people need more maths for today’s jobs, Sutton Trust, 2013

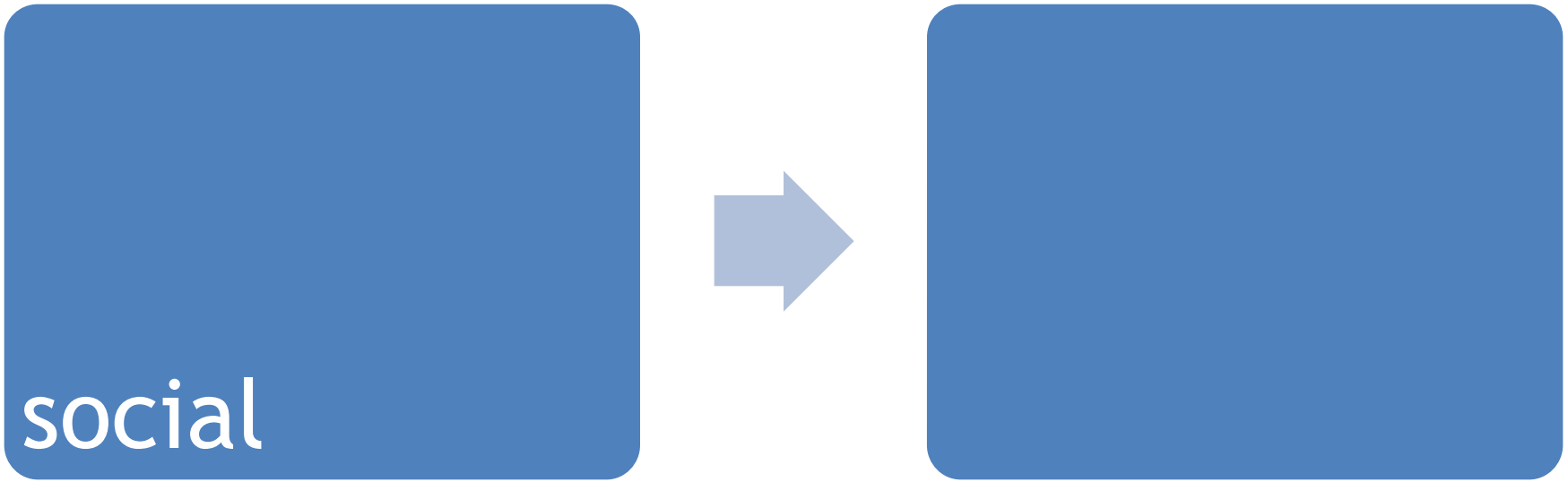
The purpose of Maths: Enquiry

Example 1	Example 2
When I speak at a conference on the topic of real-life math, the biggest point I try to get across to teachers is that there is a purpose for math beyond the classroom……..To many students the purpose of math is to learn a skill that	*Students were given cardboard rectangles and asked to work out how many would cover the top of the table. They were able to do this by adding the number needed to cover one long and one short side of*
Matt Kitchen, Ohio National Council of teachers of mathematics, March 2016	*(Teaching experiment in 1995 described in Journal for Research in Mathematics Education)*

Is technology cheating?

- George Myers 1902: the mechanical work of arithmetic should be reduced to the automatic as soon as possible. *(Mathematics in the Elementary School ll)*
- Eugene Smith 1918: not in favour of working into high schools the use of the slide rule. *(The High School Journal)*
- Japan 1965: nearly 1 million applicants took soroban exams. organised by various exam boards *(NRICH adding with the abacus)*
- Because the use of calculators in exams. affects the validity of exams. we have decided we will introduce rules governing the use of calculators in new GCSEs, AS and A levels. *(Ofqual, consultation outcome, December 2015)*
- The IB and all the six countries have high stakes examinations which permit the use of calculators in at least some of the examination papers. All allow graphic calculators and some allow calculators with symbolic manipulation. (*Report for the IB)*
- It adds a whole new dimension …..and with PowerPoint as the driving programme we are sure that we offer the students a good standard of presentation of lessons. *(Head of Maths. 2001)*

Why?



The challenges: cost

- Cost of KS3 national curriculum tests in ICT around £26m
- Five years to develop
- School infrastructure
- One-off nature of examinations

Key Skills

- A *retail store* has had to increase the price of *washing machines* by **6%.** The new price for the most popular model is £**237**. A *regular customer* persuades the store to sell one of the washing machines for the original price. How much does it cost her?
- A *football club* has had to increase the price of its *season tickets* by **8%.** The new price for a season ticket is £**432.** A *keen supporter* persuades the club to sell him one for the original price. How much does it cost him?

The challenges: what technology can do

Voice assistants are coming for your home and will listen to everything you say	How to keep track of your luggage: smart luggage with finger print activated unlocking
Parking apps: we don't care who we pay, we just want to park	***How to use your Apple watch to be productive***
The Misericorsa app urges Roma Catholics to share their good deed	***Health monitors can have unwanted side effect***
From The Independent (21/06/16)	

The challenges: values

Comparison of values	
Technology	***Assessment***
highly adaptable	***valid***
personalised	***reliable***
mobile	***comparable***
automatic	***manageable***
engaging	***unbiased***
immediate	***accessible***

The challenges: delivery

Proposed KS3 NC tests in ICT scrapped after pilot in 2005:

- Felt to be not face valid for level 6
- Reliability of outcomes at level 6 lower than for other levels
- Pupils using 800*600 pixels screen resolution monitor appeared to be disadvantaged compared with those using 1024*768 monitor
- Pupils who sat both test sessions with a gap of 6 days or fewer scored more highly than those who had a longer time gap between sessions
- Some aspects of the test not sufficiently content valid
- Comparison of teacher assessment and test outcomes did not provide concurrent evidence of validity for KS3 ICT tests
- Levels awarded by the ICT test low compared with other NC tests and with TA in ICT
- High % of pupils awarded no level from the tests.

(Final evaluation of the pilot, QCA 2005)

The challenges: separation

- IT development occurs separately from assessment development.
- Assessment often not understood by developers: the ‘quiz’
- ‘Fun’ over sound assessment development

The Challenges: summary

- The challenges:
- Cost
- Different values
- Inability to deliver
- Separate (remote?) from pedagogy *and* assessment (and from regulation)

Taking an on-screen maths test

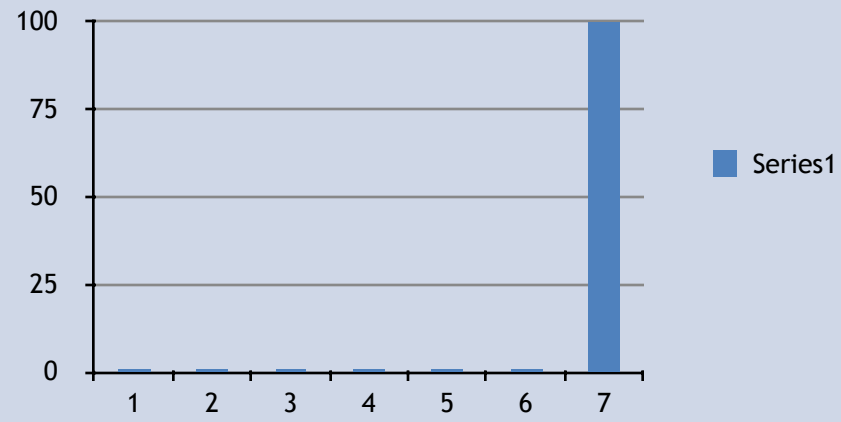
Where information isn't embedded within the question there are sometimes source documents embedded on the actual page by a tool which will be double-clicked. This will load the source material into the middle of the screen but this can be moved up and down the screen and it can also be changed in size using the arrow button on the far right hand corner which will enable the learner to minimise the document and only show the relevant information for the particular task that they are working on.

Functional Skills maths level 2 (1)

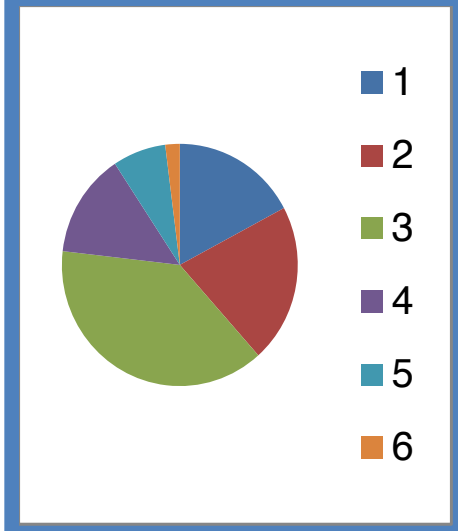
The average weekly attendances at a theme park over the last six years are shown in the table. Draw a bar chart to show the average weekly attendances over the last six years. (7 Marks)

Year	Av. Weekly attendance
2005	***84200***
2006	***69700***
2007	***66000***
2008	***75500***
2009	***72500***
2010	***69900***

Functional Skills maths level 2 (1)

On paper	On screen
Graph paper provided	
	'This question uses drag and drop functionality and a number of bars are available along with boxes to enter text. In order to access the bars to amend their height you need to hover over the bar. When the mouse changes to the little hand hold down your mouse key and drag the bars up.'

Pie Charts



The pie chart uses exactly the same drag and drop functionality. You need to hover over the relevant line at the edge of the chart and this will enable you to move it. If appropriate you will be supplied with various points to identify the angle degrees.

Functional Skills maths level 2 (1)

- Are the two versions of the question assessing the same criteria?
- Are they at the same level of demand?
- *(Functional Skills maths, Level 2: focus on the effective application of process skills in purposeful contexts; use and interpret statistical measures, tables and diagrams for discrete and continuous data.)*

Functional Skills maths level 2 –on screen version (2)

- Before Sports Day the shot put circle needs resurfacing. The shot put circle has a radius of 1.1 metres. The cost of re-surfacing is £42.50 per square metre.
- How much will it cost to resurface the shot put circle?
- $A = \pi r^2$ A = Area of circle r = radius

Working out area
Working out area
% √ π + - = ÷ [functions] %

Functional skills level 2 maths (3)

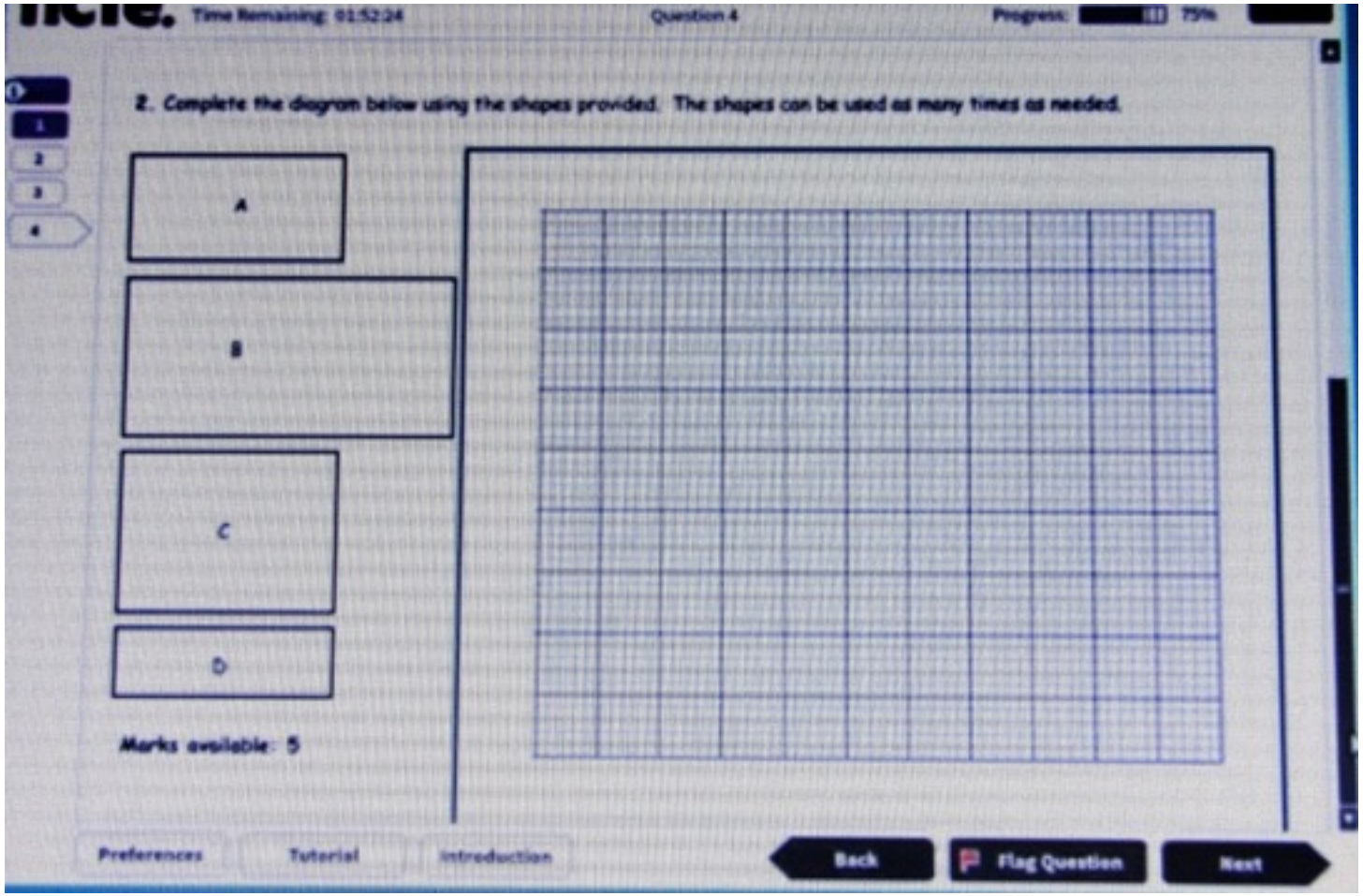
The committee is planning to give a boxed souvenir to each participant [in a cross-country race]. The box will be a cube with a picture on each of the vertical sides. The top side will have a map of the run and the bottom side will be blank. You are asked to prepare a sketch of a 2D representation of the cube with the letters

M = Map P = Picture B = Blank on the appropriate sides.

How do you do this?

What skills would be tested?

Functional Skills level 2 maths (4)



Functional Skills maths level 1 (1)

Sam is going to tile his bathroom.
Sam plans to make this border using white **and** coloured square tiles.
Each tile is the same size, but some tiles must be cut to make the border.

Use page 3 of the Resource Booklet

height

Not to scale

(a) What is the height of Sam's border?

Examiner use only

_____

(1 mark)

(b) How many tiles are needed to make the part of the border shown above?

Examiner use only

_____

_____

(2 marks)

Games

- Learning to count is ‘fun’……..
- Colour, sound, action
- Repetition of arithmetical functions
- Contribution to maths pedagogy or assessment development……

The future?

- The learning games field is approaching its adolescence….[which] is …aligned with an unprecedented interest, emphasis and outright demand for innovation in assessment in education.
- Games and assessment structures are a unique and useful marriage …..[and] the intersection of these two …has the potential to move the field forward to more engaging and transformative play experiences.

(*Better Learning Games, MIT, 2015)*

Characteristics

- Uses conceptual design framework (Evidence Centered Design), developed by ETS.
- Defines and aligns the content, evidence and criteria for understanding student's learning/ performance on a task/game.
- Establishes a framework for the content, the task and the evidence.
- Enables the game to provide and use evidence of achievement.
- Game designers work in concert with instructional designers, content or subject matter experts and assessment specialists.

Example (Quest)

- The *Radix Endeavour* is a Massively Multiplayer Online Game (MMOG)being developed by the Education Arcade at MIT designed to improve learning and interest in STEM in high schools students. The content specifically focuses on statistics, algebra, geometry, ecology, evolution, genetics, and human body systems. Players take on the role of mathematicians and scientists and embark on quests that encourage them to explore and interact with the virtual world through math and science. Players become embedded in a narrative in the world where they encounter a villain who does not believe in the practices of science. Players have to reason about science issues applicable to game characters' everyday lives, refute the unscientific claims of the villain and make choices based on what they consider to be valid evidence.

Example (Quest)

Content Model	Task Model		Evidence Model	
Learning Objective	*Quest*	*Task/action*	*Data collected*	*Interpreting evidence*
Recognise patterns in data sets	*ST1.1*	*Turn in data summary to support or refute government claim*	*Data summary (see Table 1.7 for possible data summary submissions)*	*Correct:* Player knows to use a large enough sample size and the correct measure *If incorrect:* - *Species other than a blackburn:* player likely does

Lure of the Labyrinth

‘Lure of the Labyrinth is a digital game for middle-school pre-algebra students. It includes a wealth of intriguing math-based puzzles wrapped into an exciting narrative in which students work to find their lost pet –and save the world from monsters. Linked to both Common Core and national standards the game gives students a chance to actually think like mathematicians.’

Lure of the Labyrinth

www.labyrinth.thinkport.org

Rt. click open hyperlink

- [click on ‘lure of labyrinth]

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