



Southwest Hub Meeting: New Technologies in Mathematics Support

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Summary

- Background
- The whole picture
- A little theory
- Examples of new technologies in maths support
- **sigma**'s investigations in new technologies
- Conclusions

Background

- What is mathematics support?
- Why is it needed?
- What is **sigma**?
- What are new technologies?
- Why are they important?

What is Mathematics Support?

Definition

Collective term for additional, supplementary teaching & learning provision in mathematics & statistics

Common forms

1. Bridging courses
2. Computer-aided learning
3. Diagnostic testing
4. Drop-in centres / workshops
5. Numeracy classes
6. Paper-based open learning materials
7. Peer study support
8. Tutoring
9. Videos
10. Websites (may include types 2, 6 and 9)

Over 50% of UK HEIs offer some form of maths support (Beveridge, 1997; Perkin & Croft, 2004)



Why Mathematics Support?

- Rapid decline in maths skills of HE entry students (see below)
 - Massive increase in student numbers
 - Professional graduate standards \Rightarrow fairly constant assumed entry mathematical knowledge
 - Wider cohort diversity (WP & internationalisation)
- \Rightarrow Traditional (curriculum based) teaching methods alone are ineffective in addressing these requirements, even with good teaching practices, c.f. Recommendation 3.1 (Roberts, 2004)

Entry Year	1991	2001
A-Level Grade	N	B
Av. Diagnostic Test Score	34.4	33.8

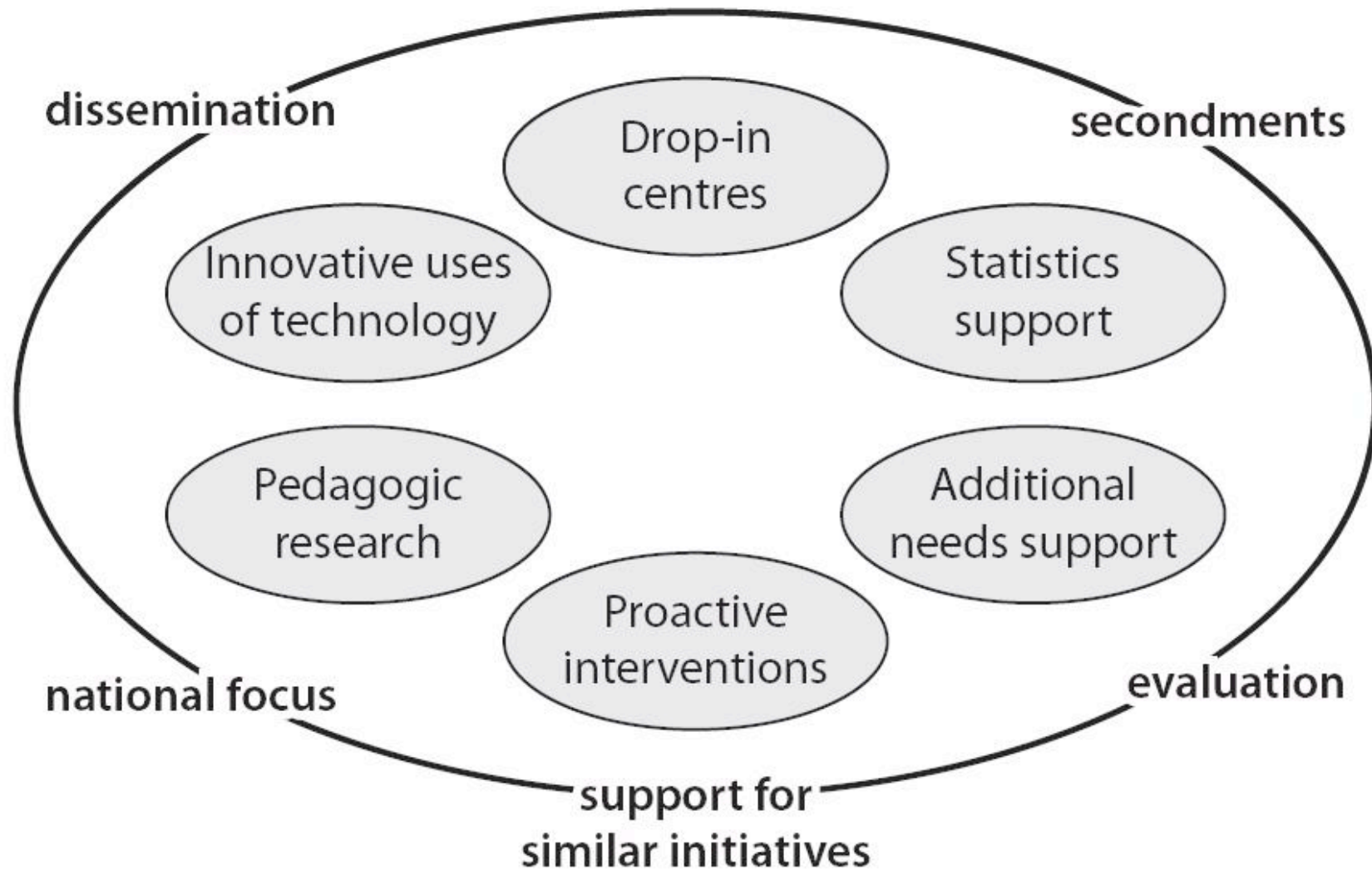
A-Level grade vs. mark on static maths diagnostic test, source: (Lawson, 2003)

What is sigma?

- One of 74 Centres **for** (not 'of') Excellence in Teaching & Learning (CETLs)
- Aim of CETL scheme: promote 'beacons' of good practice in the UK HE sector
- £4.5m funding from HEFCE
- Award based on existing good practice at Coventry & Loughborough
- Running from 2005 to 2010
- **sigma** is probably the most active CETL in disseminating and promoting its activities for the benefit of the rest of the UK HE sector

sigma 

sigma activities



What are new technologies?

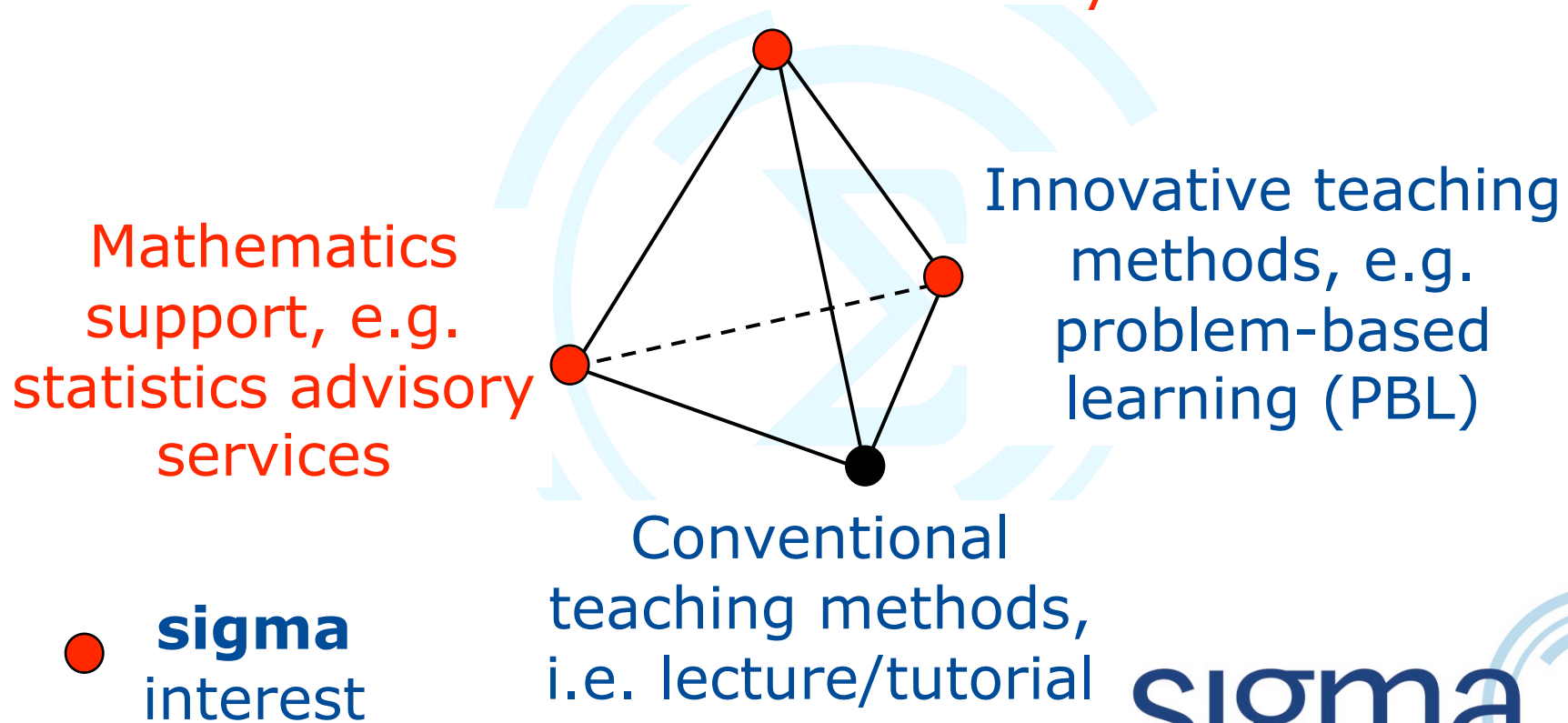
- Virtual learning environments:
 - Computer assisted assessment
 - Reusable learning objects
- Communications technologies (e.g. Audio-Video-Text software)
- Mathematics & statistics software environments, e.g. integrated dynamic geometry & computer algebra systems
- Mobile devices
- Web 2.0 and social networking
- Serious games
- Personalisation

Why are they important?

- Reflect current social practices and preferences of contemporary learners \Rightarrow have the potential to **engage** learners where traditional teaching methods are becoming inadequate
 - Can overcome some of the social limitations of traditional methods (e.g. can assist peer learning or overcome embarrassment in feedback)
 - Some smart technologies have the potential of enhancing teaching
 - Might make teaching more efficient & economical
- \Rightarrow Specific aim of **sigma**: to take risks in new technologies in maths support on behalf of the UK HE sector

The whole picture: excellence in HE mathematics teaching

Innovative uses of technology in mathematics teaching, e.g. classroom communication systems



Excellence in conventional maths teaching:

- E.g. contextualised staff development by MSOR

Innovative teaching methods in HE maths:

- Mainly individual enthusiasts (PBL becoming popular)
- Some coordination in the 1990s, e.g. (Houston, 1994), MathsSkills project (Hull)

Innovative uses of technology in mathematics teaching:

- Similar to innovative teaching methods
- Increased general use of VLEs – but what for?
- **Too much emphasis on new technology rather than pedagogy & evaluation** (Kirkwood & Price, 2005)

Pressure on institutions to move away from conventional teaching methods, e.g. Faculty of Engineering & Computing at Coventry's change of pedagogy to Activity Led Learning

A little theory

1. Prensky's digital natives
2. Hartley's model of 3 different social uses of technology
3. The Web 2.0 paradigm shift
4. Convergence between new learning and new technology
5. Learning in the 21st Century & mobile learning
6. Feasibility of mobile connectivity
7. Theory of engagement

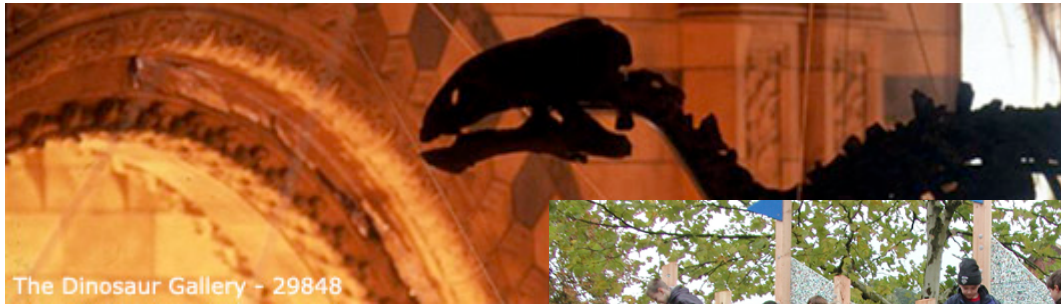
Theory 1: Prensky's digital natives

It is now clear that as a result of this ubiquitous environment and the sheer volume of their interaction with it, today's students think and process information fundamentally differently from their predecessors. These differences go far further and deeper than most educators suspect or realize.

(Prensky, 2001)



Theory 2: 3 different social uses of technology (Hartley, 2007)



The museum



The playground

The refuge



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Collision of learning spaces

The Museum:

Formal, public, controlled
Institutional world of control
and individual assessment

e.g. Virtual
Learning
Environments

e.g. Facebook

The Playground:

Collaborative, informal, exploratory
The world of facilitation and enquiry

e.g. iPod

The Refuge:

Personal, private and exclusive

**E-learning: "the new
fight in the playground"**

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Theory 3: The Web 2.0 paradigm shift (O'Reilly, 2005)

- Not a software package – a different way of thinking about the internet
- Emerged from '.com' bubble bursting in 2001: wrong business model
- **Web 1.0** = software packages, information control, isolated, non-participatory, publishing, release versions
- **Web 2.0** = free internet services, user control of data, radical trust, collaborative, continuous improvement, cost-effective scalability, exploits the 'long tail' of small websites: 'architecture of participation'

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Theory 4: Convergence between new learning and new technology (Sharples Et Al., 2007)

New Learning	New Technology
Personalised	Personal
Learner centred	User centred
Situated	Mobile
Collaborative	Networked
Ubiquitous	Ubiquitous
Lifelong	Durable (?)

⇒ Importance of mobile learning



Theory 5: Learning in the 21st Century

- In the 1990s challenge was to provide PC labs
- Locus of learning is changing very quickly – away from the lab/classroom/lecture theatre



- Advances in mobile and ubiquitous computing – create ways to go beyond 'traditional e-learning'
- Challenge now is to establish an integrated approach to learning environments – both real and virtual

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Mobile & wireless devices



laptops



mobile phones



digital camcorders



MP3 & MP4 players, e.g. iPods



Classroom communication systems



tablet PCs



portable DVD players



digital voice recorders



electronic paper e.g. Sony Librie



smartphones



Ultra Mobile PCs



PDA's

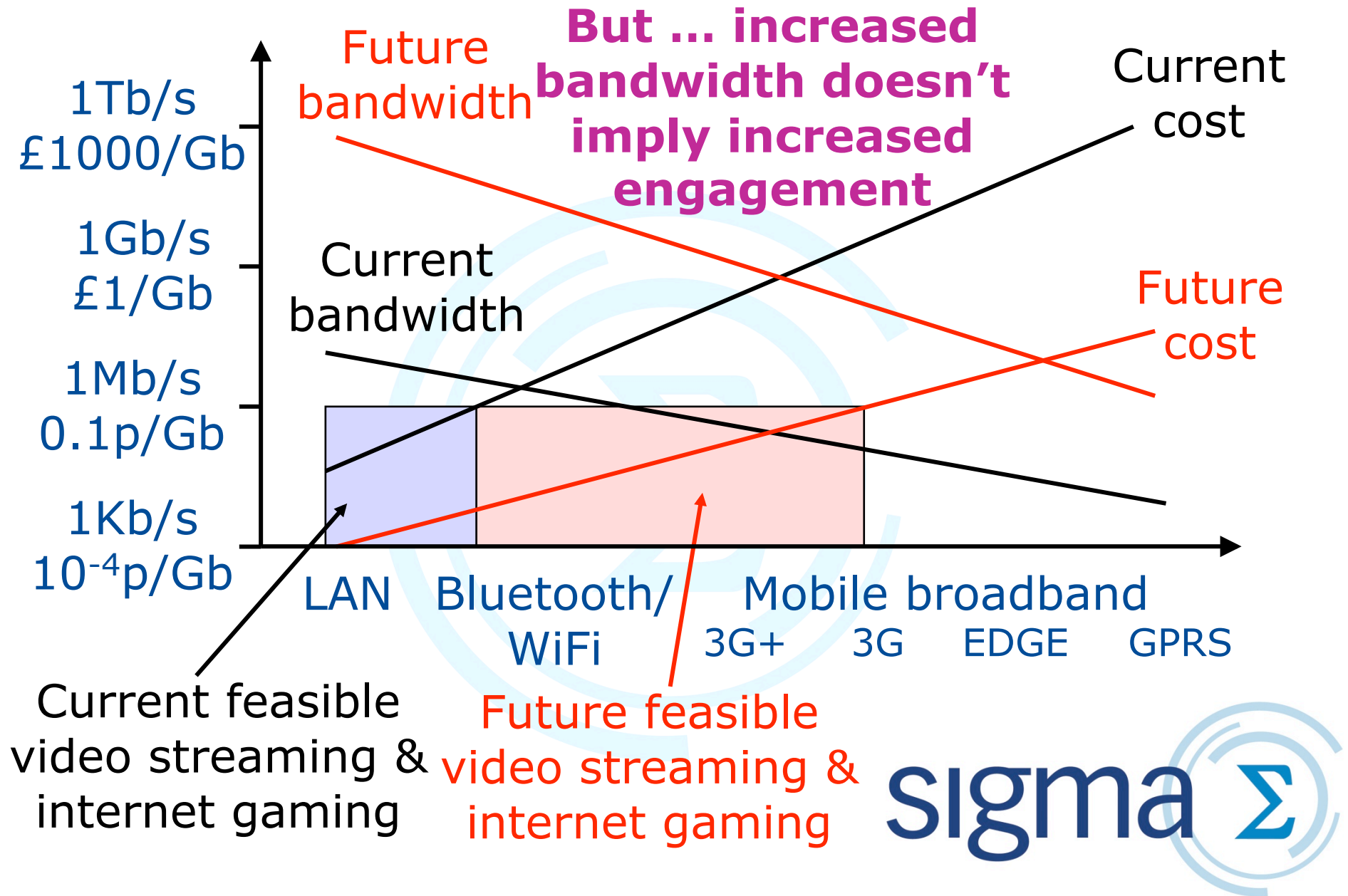


games consoles e.g. Sony PSP

Need for platform standards, e.g. MID, Java

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Theory 6: Feasibility of mobile connectivity



Theory 7: Engagement (Fredricks Et Al, 2004)

Behavioural - type of conduct, degree of involvement in learning and academic tasks, and degree of participation related activities

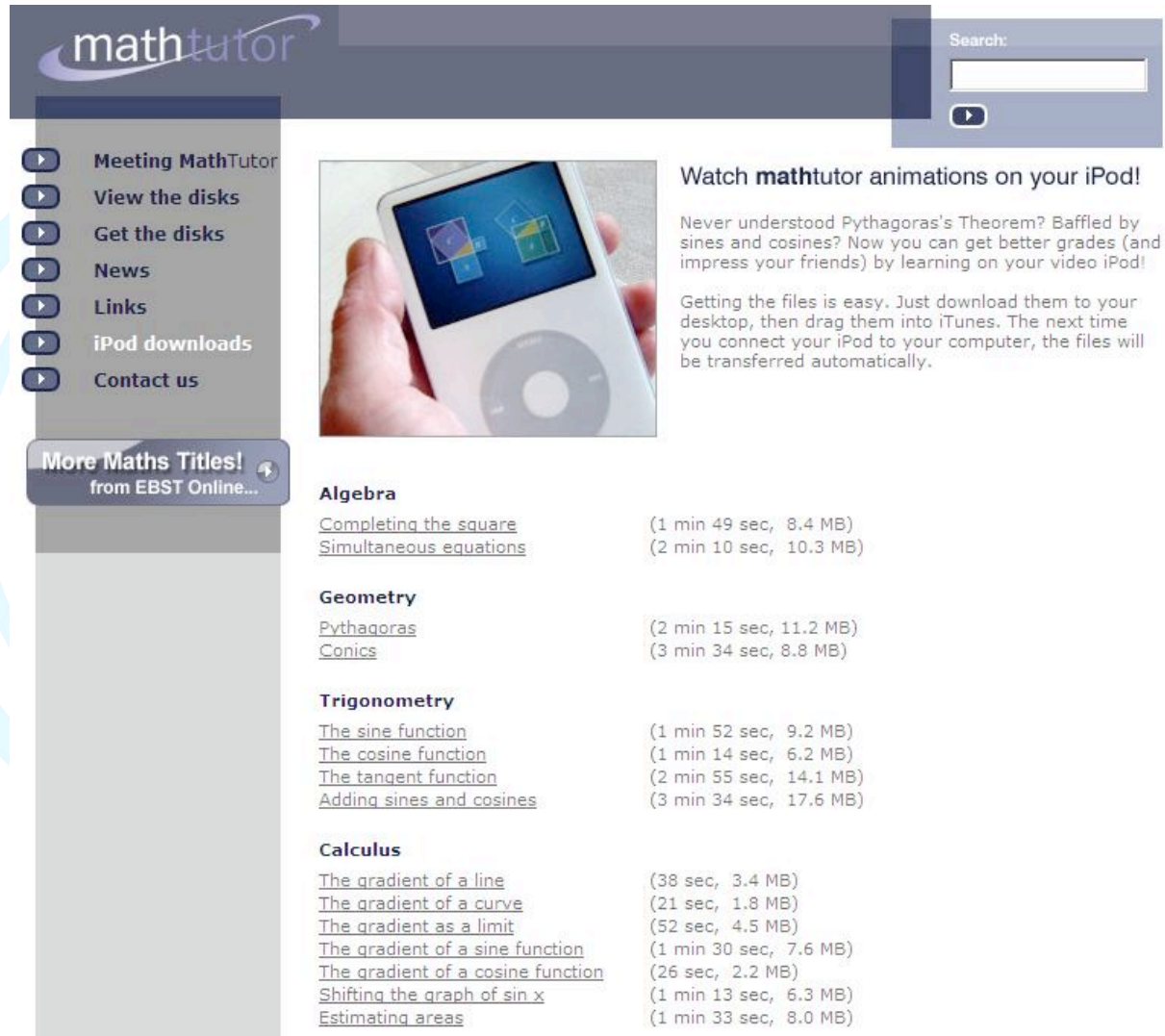
Cognitive - psychological investment in learning or cognition and strategic learning

Emotional - affective reaction to academic activities

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Examples of new technologies in maths support: 1. Video podcasts via the mathtutor website

- 15 short clips currently available
- Impact?



The screenshot shows the mathtutor website interface. At the top left is the 'mathtutor' logo. To the right is a search bar with a play button icon. Below the logo is a vertical navigation menu with the following items: Meeting MathTutor, View the disks, Get the disks, News, Links, iPod downloads, and Contact us. Below the menu is a button that says 'More Maths Titles! from EBST Online...'. The main content area features a video player showing a hand holding an iPod with a math animation on the screen. To the right of the video player is a heading 'Watch mathtutor animations on your iPod!' followed by two paragraphs of text. Below this is a list of video titles categorized by subject: Algebra, Geometry, Trigonometry, and Calculus. Each title is followed by its duration and file size in parentheses.

Search:

▶ Meeting MathTutor
▶ View the disks
▶ Get the disks
▶ News
▶ Links
▶ iPod downloads
▶ Contact us

More Maths Titles! from EBST Online...

Watch mathtutor animations on your iPod!

Never understood Pythagoras's Theorem? Baffled by sines and cosines? Now you can get better grades (and impress your friends) by learning on your video iPod!

Getting the files is easy. Just download them to your desktop, then drag them into iTunes. The next time you connect your iPod to your computer, the files will be transferred automatically.

Algebra

Completing the square	(1 min 49 sec, 8.4 MB)
Simultaneous equations	(2 min 10 sec, 10.3 MB)

Geometry

Pythagoras	(2 min 15 sec, 11.2 MB)
Conics	(3 min 34 sec, 8.8 MB)

Trigonometry

The sine function	(1 min 52 sec, 9.2 MB)
The cosine function	(1 min 14 sec, 6.2 MB)
The tangent function	(2 min 55 sec, 14.1 MB)
Adding sines and cosines	(3 min 34 sec, 17.6 MB)

Calculus

The gradient of a line	(38 sec, 3.4 MB)
The gradient of a curve	(21 sec, 1.8 MB)
The gradient as a limit	(52 sec, 4.5 MB)
The gradient of a sine function	(1 min 30 sec, 7.6 MB)
The gradient of a cosine function	(26 sec, 2.2 MB)
Shifting the graph of sin x	(1 min 13 sec, 6.3 MB)
Estimating areas	(1 min 33 sec, 8.0 MB)

Examples of new technologies in maths support: 2. Nintendo DS with nursing students

- Problems with numeracy
- High anxiety

Advantages of Nintendo DS:

- Wide demographics for recreational gaming (e.g. cooking, brain training)
- Can develop contextualised resources (e.g. drug calculations with graphics using Flash)

Institutions currently using them:

- Coventry
- Suffolk



Examples of new technologies in maths support: 3. FETLAR

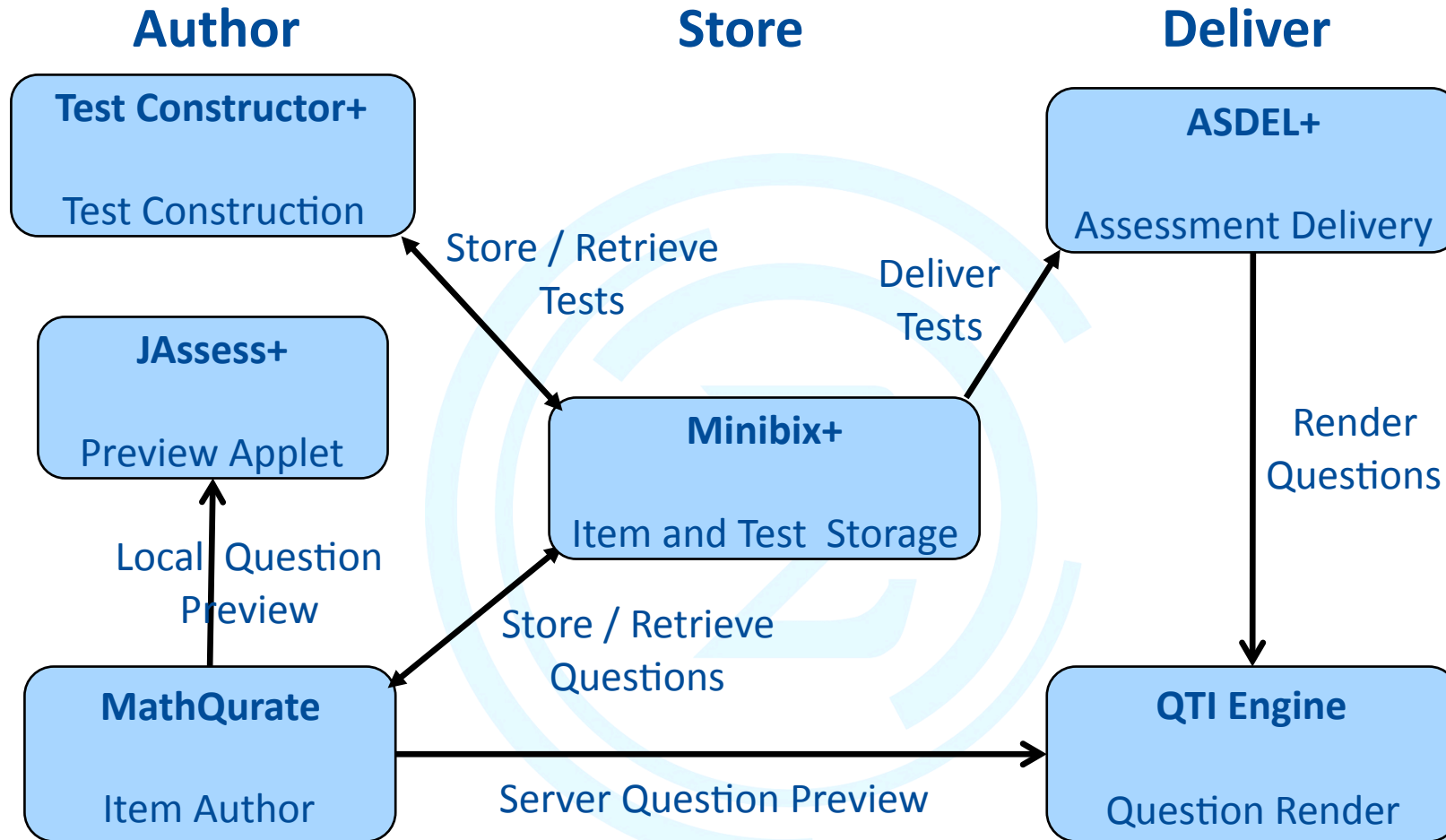
- Finding Electronic Teaching, Learning & Assessment Resources
- A JISC/HEA Open Education Resources project
 - outputs to be made freely available to all
- 12 month Project from 1/05/09
- Main focus: reuse of e-assessment objects
- Aims:
 - Collect mathematics e-resources
 - Technical work to assemble them
 - Try out & evaluate resources in the 'real' curriculum

FETLAR resources offered

Institution	Resource	Description
Anglia Ruskin University	NuMBerS	Resources for numerical methods for the biosciences
Coventry University	Just the Maths	Modularised resources for foundation level and first year degree level courses
Glasgow Caledonian University*	CALMAT	Computer Aided Learning in MAThematics software suite for GCSE, A-level and first year university students
Leeds University	Maths Solutions	Short video clips of solutions to a series of maths problems known to challenge students
Loughborough University	mathcentre & mathtutor	Around 900 learning objects to help students who have difficulty at the transition to HE
Nottingham Trent University	METAL	A variety of resources to support mathematics for economics
Newcastle University	DIAGNOSYS	A knowledge-based test of basic mathematical skill

* **Note:** Informal permission not yet received

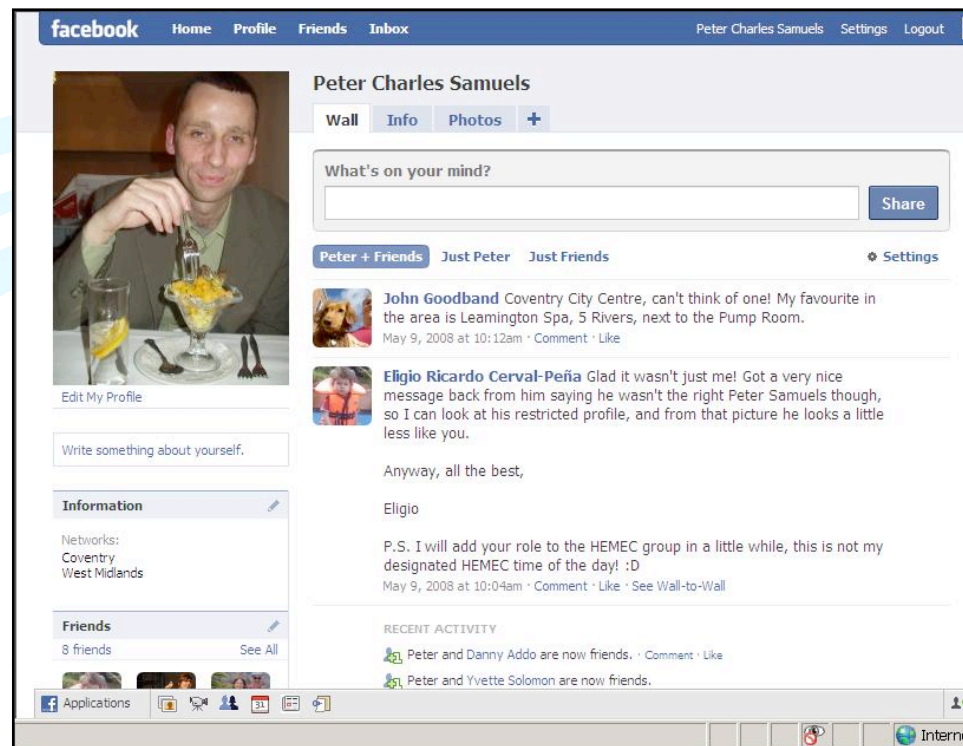
E-Assessment in FETLAR builds on MathAssess tools



QTI compliant \Rightarrow 'future proof'

Examples of new technologies in maths support: 4. sigma's experiences with Facebook

- World's most active Social Networking Site
- Familiar technology to 'net generation' students
- Potential effective use in HE: Match social context of learning & Provide peer support
- Used by **sigma** to support maths students at Coventry
- 4 different groups
- Evaluation: interviews & focus groups



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Findings

- Social & physical environment more important factors than the virtual environment (e.g. new drop-in centre, strong student personalities)
- Generally 'low bandwidth' communication – social aspects of learning
- Problems with student ownership when started by staff
- Problems with equality & appropriateness when started by students
- **Solution:** Facebook group based on a student society set up by postgraduate students
- Appears to be more effective with postgraduate students (e.g. HEMEC conference)

sigma's investigations into new technologies

1. Evaluations of new technologies
2. Feasibility of mobile devices for HE maths learning
3. Proof of concept studies
4. Technologies implemented in Proactive Teaching Programme
5. Technologies chosen for further investigation in final year of **sigma**

1. Evaluations of new technologies

- 'Warts and all'
- Emphasis on technical aspects
- 13 evaluations currently available from **sigma** website

The screenshot shows the sigma website's 'Evaluating New Technologies' page. The header includes the sigma logo (centre for excellence in mathematics & statistics support) and a navigation menu with links for Home, About Us, Activities, Resources (highlighted), Evaluation, and Contact Us. A search bar is also present. The breadcrumb trail reads 'You Are Here: Resources > Evaluating New Technologies'. The main content area features the title 'Evaluating New Technologies' and three images of technology: a Hitachi XGA Portable Data Projector, an iPod, and a Pen Tablet. Below the images is a paragraph explaining that capital funding has enabled sigma to purchase a wide range of new technologies aimed at improving the learning experience of students. The page also includes a list of seven guides: Guide #1: Using TV for Presentations, Guide #2: Hitachi XGA Portable Data Projector, Guide #3: ELMO Visual Presenter (Document Reader), Guide #4: The Pen Tablet, Guide #5: A Beginners Guide to Podcasting, Guide #6: Microsoft PowerPoint Slideshow Narration, and Guide #7: Voting Systems: Turning Point Technologies. On the left, there is a 'Resources' sidebar with links to Video Tutorials, mathcentre, Facts and Formulae Leaflets, Good Practice in Maths Support Centres, HELM Learning Resources, MSOR Network, mathtutor, Statistics FAQs, Evaluating New Technologies, Maths Study Skills Leaflets, Mobile Learning Feasibility Study, Maths Support Assoc. Newsletter Articles, and two newsletters. On the right, there are 'Quick Links' to Coventry University's Mathematics Support Centre and Loughborough University's Mathematics Education Centre, and 'Key Contacts' listing Dr Joe Ward.

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in mathematics & statistics support

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Search

You Are Here: Resources > Evaluating New Technologies

Resources

- Video Tutorials
 - for iPods
 - for mobile phones
- mathcentre
- Facts and Formulae Leaflets
- Good Practice in Maths Support Centres
- HELM Learning Resources
- MSOR Network
- mathtutor
- Statistics FAQs
- Evaluating New Technologies
- Maths Study Skills Leaflets
- Mobile Learning Feasibility Study
- Maths Support Assoc. Newsletter Articles
 - Newsletter 1
 - Newsletter 2

Evaluating New Technologies



Capital funding has enabled **sigma** to purchase a wide range of new technologies aimed at improving the learning experience of students. Through our Innovative Uses of Technologies Group, we are testing emerging technologies in "real" situations and report on such matters as training required, problems associated with setting-up, ease of use and feedback from students. The aim is to tell it as it is - "warts and all" - and not gloss over difficulties. The current list of findings is listed below.

- Guide #1: Using TV for Presentations
- Guide #2: Hitachi XGA Portable Data Projector
- Guide #3: ELMO Visual Presenter (Document Reader)
- Guide #4: The Pen Tablet
- Guide #5: A Beginners Guide to Podcasting
- Guide #6: Microsoft PowerPoint Slideshow Narration
- Guide #7: Voting Systems: Turning Point Technologies

Quick Links

- Coventry University's Mathematics Support Centre
- Loughborough University's Mathematics Education Centre

Key Contacts

Dr Joe Ward

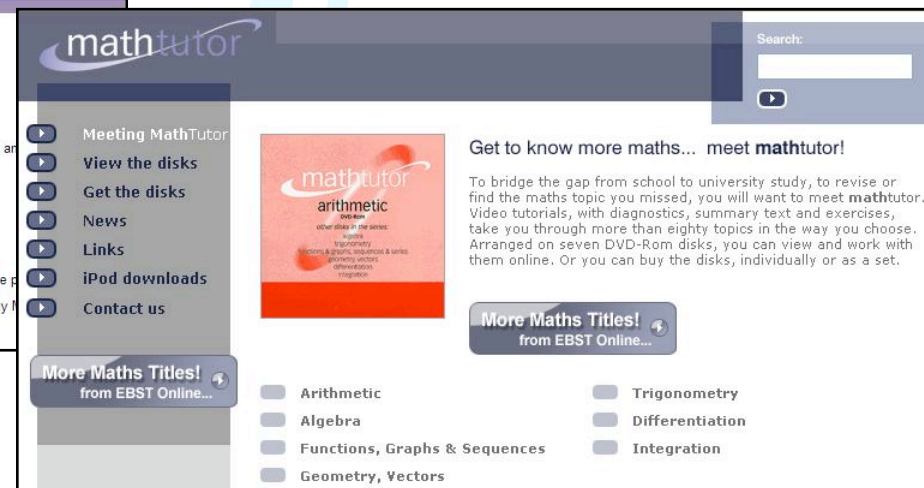
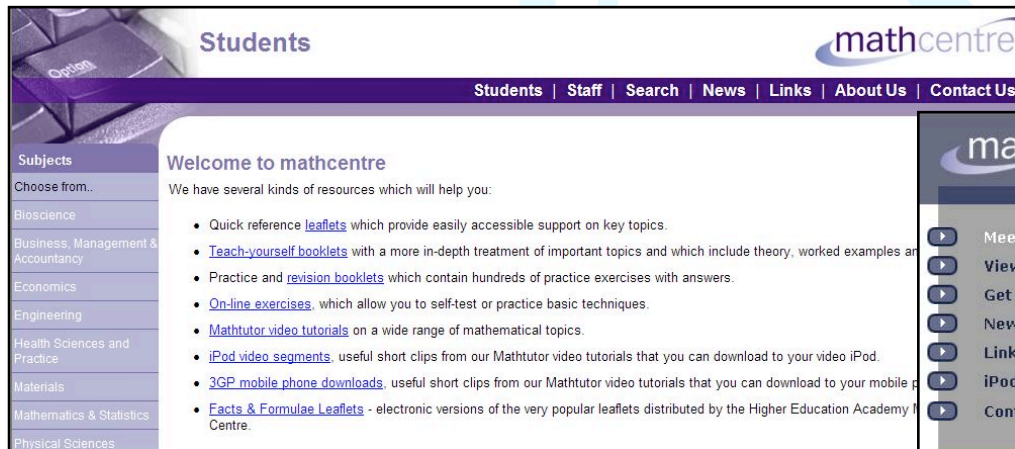
2. Feasibility of mobile devices for HE maths learning (Hu, 2007)

- More pedagogical evaluation of the potential of 8 mobile devices in HE maths learning:
 - Samsung Q1 UMPC
 - Sony Vaio UX UMPC
 - HP iPAQ PDA
 - Sony PSP
 - Apple iPod
 - Nokia N95 smartphone
 - Prada phone
 - Nintendo DS
- Also available from **sigma** website

3. Proof of concept studies (Saunders)

Aim: To investigate implementing mathcentre and mathtutor resources on mobile devices:

- Videos on iPods ✓
- Pdfs on PDAs ✗
- E-assessment on PSPs (✓) and Nokia N95s (✓)




4. Technologies used in Proactive Teaching Programme

- Aim of programme: to reduce failure rates in maths modules by targeting 'at risk' students by deploying a support intervention
- Main uses of technology:
 - Classroom Communication Systems with engineering maths (Goodband)
 - Video & online tests to support self-paced learning in discrete mathematics (Samuels)



Two natives, C and D approach you and C says "Both of us are knaves".
 $c = \text{"C is a knight"}$
 $d = \text{"D is a knight"}$
Use truth tables to determine what C and D are.

c	d	$S(c)$
T	T	
T	F	
F	T	
F	F	



5. Chosen technologies for further investigation in final year of sigma

1. Classroom communication systems (Robinson & King, Boyle)
 2. **Elluminate** (Audio-Video-Text software)
 3. Lego Mindstorms NXT robots
 4. Graphics tablets
- Also interested in GeoGebra



Conclusions

- Learners are changing and less easily engaged with traditional methods
- Learning is becoming more mobile and ubiquitous
- Technology is becoming smarter
- Importance of theory & pedagogy when using new technologies
- Introduction to some new technologies in maths support and HE maths learning

Any questions?

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www.sigma-cetl.ac.uk

Thank you!

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