

Innovative multimedia approaches to mathematics education

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Abstract

There are currently three innovative multimedia projects in the United Kingdom which integrate the use of digital video resources to enhance and support mathematics education.

These are:

- Teachers' TV (Teachers' TV 2005);
- The Mathematical Toolkit (The UK Mathematical Association/Intel plc, 2005);
- The BBC Digital Curriculum BBCjam. (BBC 2005).

This paper describes the context for each of these developments and reports on the early impact of each project, as appropriate.

Keywords: mathematics education, teacher development, digital video, digital multimedia

1. Teachers' TV

The use of video as a media to research, share and disseminate effective teaching practices has been used in many settings, notably the research of Stigler and Hiebert (1999) as part of the TIMMS study. However, in the UK the Department for Education and Skills (DfES) has funded the development of *Teachers' TV*, an editorially independent dedicated television channel broadcast on Satellite and Freeview aimed initially at teacher development across the age and subject range.

The first audience survey, conducted on behalf of the DfES, concluded,

Teachers' TV has been on air for over a year and it's a success: 90 per cent of its target audience know about it, 40 per cent have tried it and more than 20 per cent are watching it regularly. The channel has established itself as an integral part of the education landscape. (Ipsos Mori 2005).

The authors have acted as educational consultants for most of the mathematics programmes, several of which have featured the role and use of technology in secondary mathematics classrooms.

These programme titles include:

- *New Maths Technology*: The programme was filmed in the mathematics department of a state secondary school in the South of England that had just been provided with interactive whiteboards in its mathematics classrooms. The programme begins with a typical department meeting in which the teachers are introduced to a new technological tool, in this case the *Dynamic number line tool* (Clark-Jeavons 2006, Oldknow and Taylor 2000). The programme follows one of the teachers as he uses this resource in his classroom for the first time with a class of 11-12 year olds. Three other mathematics lessons feature in the programme, which include Texas Instruments *TI84* graphical calculators with *TI SmartView*, *The Geometer's Sketchpad* and the Texas Instruments *Calculator Based Ranger*.



Figure 1 The department at Tanbridge House School, UK discussing *The Number Line tool*.

- Demonstrating and Using Dynamic Geometry: The two 15 minute programmes in this series offer an expert “walk-through” the main features of *The Geometer’s Sketchpad* followed by some examples of activities involving pupils.
- Motivating Maths - Away from the Textbook: This programme was filmed as part of a project *Motivation and Relevance: Beyond Key Stage 3 in the Mathematics Curriculum*, which involved Hampshire Local Authority, University of Chichester and 5 schools. It features one of the project teachers using Texas Instruments TI83 graphic calculators for a statistical enquiry with a class of 15-16 year olds.
- Hard to Teach Maths - Quadratic Functions: A cross curricular context involving the modelling of quadratic graphs using techniques described by Oldknow (2003).

Initial feedback on the impact of the mathematics programmes on teachers’ classroom practices is being collected through a forum created on the National Centre for Excellence in Teaching Mathematics (NCETM) web portal <http://www.ncetm.org.uk/>. In addition Tanner (2006) reports one mathematics teacher’s evaluation of the resource.



Figure 2 The Discussion forum on the NCETM website.

The Mathematical Toolkit

The Mathematical Toolkit is a free web-based resource that provides teachers and learners a tool with which to explore functions and graphs, statistical charts and 2-D shapes presented with an easy to use Macromedia Flash interface that is particularly effective on an interactive whiteboard. The *Graphing* functionality offers still and video digital images as rich contexts for mathematical modelling within the 11-16 age range.

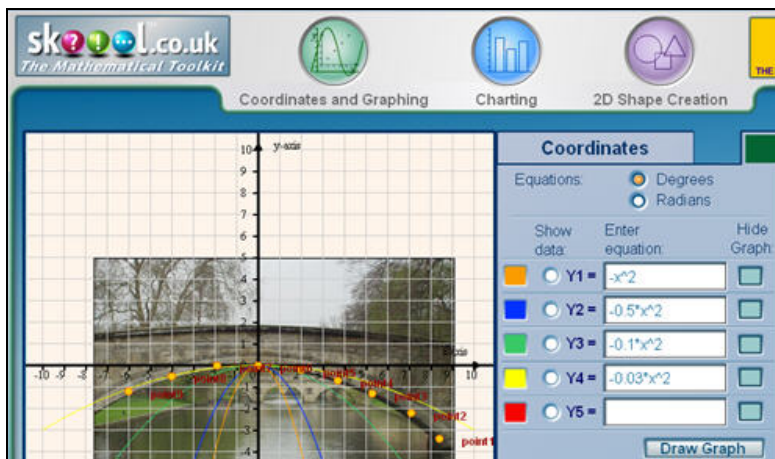


Figure 3 Modelling the curvature of a bridge.

Using an approach originally described by Olknow (2003) which used dynamic geometry software, *The Mathematical Toolkit* contains a small library of still and video images which can be used as a backdrop to the Graphing tool. These act as a backdrop to the graph plotter and allow the plotting of points by mouse click or touch (if being used in conjunction with an interactive whiteboard). Functions are then overlaid as pupils attempt to model an identified feature of the image, for example in Figure 3, the curvature of the bridge. This modelling approach encourages pupils to conjecture an initial curve and then, by transformation of the function, develop the model further. This practical approach around a motivating context is more likely to engage pupils with the mathematics and creates a sense of purpose for the learning of transformation of functions.

If a video clip is chosen, an extra set of tools allow the user to step through frame-by-frame, plotting the loci of a moving object to give a path to be modelled.

A Version 2.0 of the software is currently in development which we anticipate will enable users customise their version of the Toolkit by loading their own still and video digital images through an easy to use interface.

2. Innovative multimedia resources for learners

The final project is a 150 million UK£ project *BBCjam* overseen by the British Broadcasting Association (BBC) to provide a free online “digital curriculum” across the age and subject range for learners from 5 -16. There has been much controversy over this development resulting in an EEC directive which restricted the digital curriculum to 50% of the National Curricular for England, Wales, Scotland and Northern Ireland.

For Mathematics 14-16 this limited the content to:

Number:

- The number system: integers, indices, fractions, decimals, percentages, irrationals/surds, ratio and proportion.
- Numerical methods: trial and improvement, accuracy, units, orders or magnitude.

Algebra:

- Algebraic Methods: solving equations (linear, quadratic, simultaneous), functions, proportionality.
- Functions and graphs: sequences, generating functions, graphs of functions, transformations of functions.

Geometry:

- Reasoning geometrically with angles and shapes in 2 and 3 dimensions

- Transformational geometry: rotation, reflection, translation, enlargement, congruence, co-ordinates, vectors.
- Loci.

The authors are developing the mathematics content for the Mathematics 14-16 resources which utilise a highly interactive approach, taking popular BBC programmes such as *Top Gear* as their contexts and developing interactive elements that emanate from the programme narrative.

An example of a programme in development takes its context from a particular episode of *Top Gear*, in which the presenters race each other from a town in the South of England to Monte Carlo, Monaco. The race involves one presenter (Jeremy Clarkson) driving an Aston Martin DB7, taking a fast ferry service across the channel, whilst the other pair of presenters (Richard Hammond and James May) walk, take buses, trains and the Eurostar service. The television programme reveals a few clues with regards to times, distances and speeds, however the viewer does not have enough information to judge the closeness of the race at the finish.

In the interactive mode, the mathematics of the race is exposed to the learner through graphs and data created to complement the video of the journey and the learner is encouraged to consider the “cost” of a range of means of transport in terms of time, fuel and Carbon Dioxide emissions. A series of activities encourage learners to consider different sets of constraints to enable them to complete the race and “beat Clarkson”.

The principles behind the BBCjam service are that learners should *Explore, Learn and Create* using interactive features within the software. Within the *Top Gear* interactive, the *Explore* phase would allow the learner to select (by drag and drop) a range of graphs generated from the original *Top Gear* race to compare the “cost” in money, time, energy, carbon etc. of each journey against time. The *Learn* phase would offer the learner a toolkit to drag the journey sequences (represented by a short video icon) to a timeline. When the video sequence is “played” a graph of any chosen variable against time is generated. The *Create* phase provides the learner with drag and drop elements to devise their own race plan and test it against Clarkson in pseudo real-time. A range of mathematical and physical constraints provide both variety and challenge for learners of different levels of mathematical ability.

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