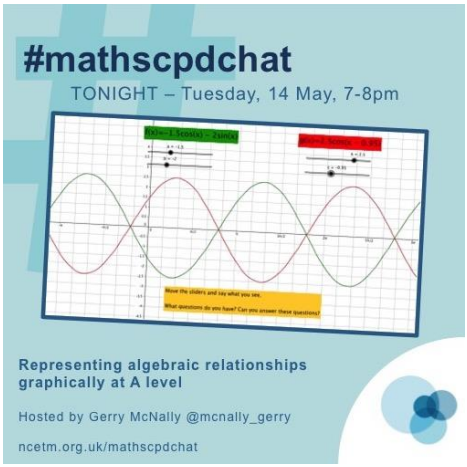
National Centre for Excellence in the Teaching of Mathematics

#mathscpdchat 14 May 2019

Representing algebraic relationships graphically at A level

Hosted by Gerry McNally

This is a brief summary of the discussion – to see all the tweets, follow the hashtag ***#mathscpdchat*** *in Twitter*



Some of the areas where discussion focussed were:

- **comparing the demands and content** of the Scottish National 5 and Higher examination curricula with those of the English GCSE and A level curricula;
- **using *Underground Mathematics* tasks and resources** (such as those involving quadratics and polynomials) … (see links below) … that these resources provide opportunities for students to discuss their thoughts, to reason, investigate and be creative while they practise and apply mathematical knowledge and procedures … using graphing software, such as *Desmos*, to construct and explore functions;
- **presenting sketch-graphs in *Which one doesn't belong?* challenges** … the value of such challenges as starting-points, as focus-points that stimulate thought and discussion;

- **matching functions expressed in the form *y* = f(*x*) to sketches of graphs** … whether or not students (should/do) use electronic aids, such as graphing calculators or software, when working on such tasks;
- **selecting the most appropriate/useful/available graphing software** to use for a particular purpose … teachers' reasons for using *Autograph*, *Desmos*, *Geogebra* or *Cinderella* software to achieve particular aims;
- that graphing software and calculators are a 'massive help' because they **enable students to check quickly their conjectures** (eg about graphs and relationships) … applying the (process) mantra 'algebra – picture – algebra';
- using **MEI's resources for integrating technology into teaching and learning** … (see links below) … the resources using graphical calculators, *Desmos* or *Geogebra*;
- that, because **mathematical terminology** is so important (at A level), the sooner that pupils learn to use and apply the terminology correctly the better … foundations should be laid in early Key Stages;
- that pupils **sketching graphs on their own individual mini-whiteboards** enables and encourages productive pupil-pupil and pupil-teacher interaction and discussion … for example when sketching graphs of functions given lists of their properties;
- students seeing, understanding and expressing the **significance of particular points on graphs** … for example of points where graphs intersect each-other, intersect an axis, or change direction;
- using **graphical-representation to algebraic-representation 'match-up' tasks** when exploring **transformations of graphs** … when exploring how particular changes to, and relationships between, algebraic representations of functions relate to particular transformations of graphs;
- that, when students are trying to derive information about a function from a graph, students may not appreciate the **significance of the extent of the domain in which the graph is shown**;
- **comparing the 'fascinating' nature of classroom exploration**s (for example of nth order MacLaurin/Taylor series expansions of a function using graphing software such as Desmos) **with the 'dull' nature of exam questions**;
- **whether exam questions ought/need to be 'fascinating'** (hence difficult?) or whether they should be mostly straightforward and predictable (providing opportunities for students to show how much they have learned);
- how the **degree of stress that students experience** when faced with difficult exam/test items **depends on what is 'at stake'** … comparing students' 'feelings' during A level exams with their 'feelings' during UKMT challenges!

In what follows, click on any screenshot-of-a-tweet to go to that actual tweet on Twitter.

An interesting ‘conversation’ of tweets, about students using graphing software (such as Desmos), and also mini-whiteboards, to explore relationships that are expressed algebraically, followed from this tweet by Gerry McNally:

Gerry McNally @mcnally_gerry · May 14

Most of tonight's tweets so far have been about graphing software. How important is this? What else helps when teaching graphical relationships?

including these from Chris McGrane, Simon Ball and Gerry McNally:

Chris McGrane @ChrisMcGrane84 · May 14

Replying to @mcnally_gerry

I was a big fan of @autographmaths for years and only switched to Desmsos due to being unable to install it on schools comps in Glasgow. Have grown to become a fan of @geogebra. It's harder to learn, but much more powerful. Also a shout out to Cinderella which @JohnMOxford uses

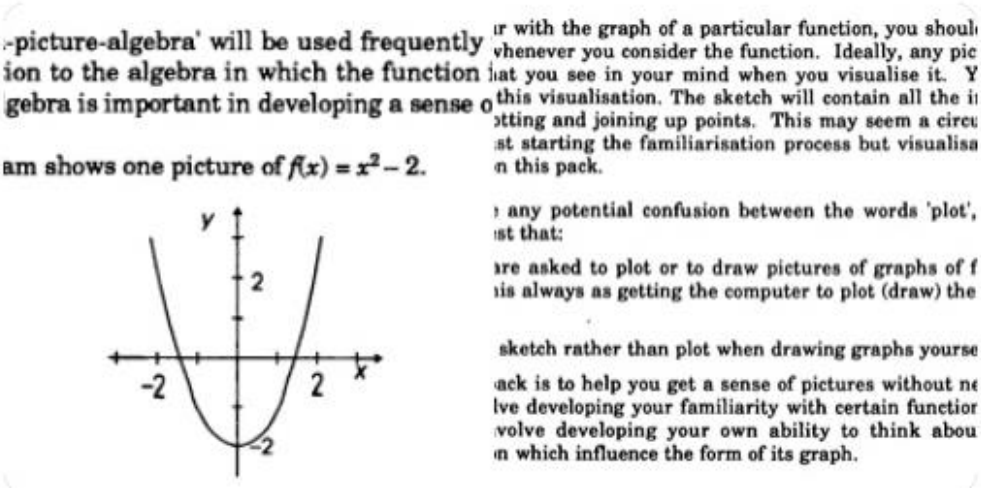
Simon Ball @ballyzero · May 14

Replying to @mcnally_gerry

Graphing software - and calculators - are a massive help as students can check relationships and any conjectures they might have quickly. I like getting mini-whiteboards out for sketches, too. I believe sketching curves gives students a different feel for them. #mathscpdchat

Gerry McNally @mcnally_gerry · May 14

#mathscpdchat Thanks for this, Simon. Here are two extracts from “Picturing Functions” by Barbara Jaworski for the Open University. I would recommend this free-to-access study pack to both new and experienced teachers of graphical relationships.



-picture-algebra' will be used frequently
ion to the algebra in which the function
gebra is important in developing a sense o

am shows one picture of $f(x) = x^2 - 2$.

ır with the graph of a particular function, you shoul
whenever you consider the function. Ideally, any pic
hat you see in your mind when you visualise it. Y
this visualisation. The sketch will contain all the i
otting and joining up points. This may seem a circu
st starting the familiarisation process but visualisa
n this pack.

any potential confusion between the words 'plot',
st that:

re asked to plot or to draw pictures of graphs of f
is always as getting the computer to plot (draw) the

sketch rather than plot when drawing graphs yourse

ack is to help you get a sense of pictures without ne
lve developing your familiarity with certain functior
volve developing your own ability to think abou
n which influence the form of its graph.

these from Mary Pardoe and Gerry McNally:

Mary Pardoe @PardoeMary · May 14

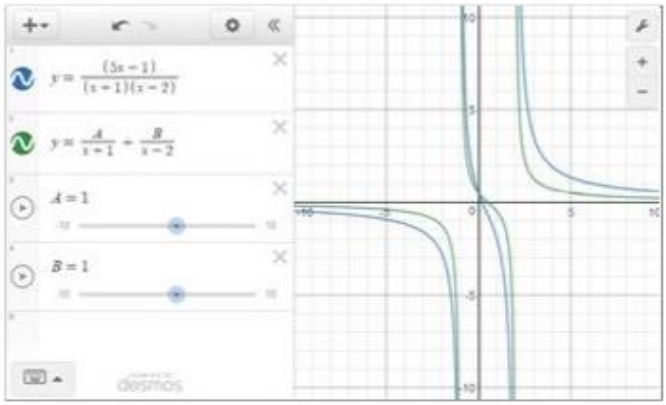
Replying to @ballyzero @mcnally_gerry

I love this ... (from mei.org.uk/desmos-tasks again) #mathscpdchat

MEI Desmos Tasks for A2 Core

Task 9: Partial Fractions

1. Enter the function $y = \frac{5x-1}{(x+1)(x-2)}$
2. Enter the function $y = \frac{A}{x+1} + \frac{B}{x-2}$ and add sliders for **A** and **B**



Find values of **A** and **B** so that the graphs of the functions are the same.

Questions for discussion

- How could you find the values using $\frac{5x-1}{(x+1)(x-2)} = \frac{A}{x+1} + \frac{B}{x-2}$?
- Does this method work for $\frac{2x+7}{(x+2)(x+3)} = \frac{A}{x+2} + \frac{B}{x+3}$?

Gerry McNally @mcnally_gerry · May 14

Lovely, Mary! "Algebra - picture - algebra" is the mantra of the "Picturing Functions" document I referenced and sampled tonight.
open.edu/openlearncreat …
#mathscpdchat

and these from Emma Mitchell and Simon Ball:

Emma Mitchell @ollieindy · May 14

Replying to @ballyzero @mcnally_gerry

I like mini whiteboards as well as I find it helps to get pupils to sketch as opposed to draw accurately and it makes them think more about what they know. #mathscpdchat

Simon Ball @ballyzero · May 14

Replying to @ollieindy @mcnally_gerry

The ability to sketch - or represent graphically - is such a vital component of the new A-Level. I'm thinking I'll be asking questions along the lines of "And what does the graph of this look like?" more often next year. #mathscpdchat

(to read the discussion-sequence generated by any tweet look at the 'replies' to that tweet)

Among the links shared were:

Picturing Functions which is freely downloadable material from the Open University. As part of the *Project Mathematics Update*, it was prepared for the Open University's Centre for Mathematics Education by Barbara Jaworski. The pack consists of sections of related tasks (with comprehensive guidance) that aim to help learners reach an understanding of functions through an appreciation of their graphs. (Scroll down the page until you reach this item.) It was shared by Gerry McNally

Integrating Technology Into Your Scheme of Work which is a section of the MEI website that provides many ideas for integrating technology into schemes of work for AS/A level Mathematics. It includes student tasks (the next link is to an example) together with teacher-guidance (suggested questions for discussion, further tasks, …). It was shared by Mary Pardoe

MEI Desmos Tasks for A2 Core: Task 2 - Inverse functions which is a task for students (with teacher guidance) in which the students use Desmos software. It was shared by Mary Pardoe

Representing Polynomials Graphically which is a *Formative Assessment Lesson* as part of the *Mathematics Assessment Project* of the *Shell Centre for Mathematical Education, University of Nottingham and the University of California at Berkeley*. It was shared by Julie Morgan

Can you find ... asymptote edition which is a 'Many ways problem' in the *Polynomials and Rational Functions* section of the *Underground Mathematics* website. The many ways of approaching this interesting problem are clearly described. As with all the many lovely *Underground Mathematics* problems, associated printable/supporting materials and 'Teacher Notes' are provided. It was shared by Mary Pardoe

You're Always Realising New Things: Graphs of Quadratic Functions (Part 2) which is an interesting article by Gerry McNally about some lessons on graphs of quadratic equations using Desmos software. It was shared by Gerry McNally

Maclaurin/Taylor Series Expansion which is a Geogebra file created by David Weppler. The user uses a slider to drag a point to create different approximations to a function f(x), which the user can define herself. It was shared by Jack Nicol