Teaching Geometric Concepts with TI-Nspire

Case Study 13

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Researchers	Alison Clark-Wilson, University of Chichester
Location	St Andrews Boys School, Worthing, UK
Course	Year 10 Fast Track
Grade	Year 10
Student Profile	11 learners in a Year 10 Fast Track class, with an approximate NC level: GCSE grade A-A* in year 10
Technology	TI-Nspire

TI-Nspire allowed pupils to explore the problem for themselves quickly and efficiently so the focus was on the intended learning rather than issues with drawing graphs that could have occurred otherwise.

Curriculum & Teaching:

Topic: Equations of Parallel and Perpendicular lines

Learning Objectives To recognise and generate the equations of lines parallel and perpendicular to given straight line graphs.
Vocabulary Perpendicular, Parallel, Gradient, Intercept
Starter Hangman of PERPENDICULAR AND PARALLEL Pupils to then write a formal definition of parallel and perpendicular using mathematical language

Introduction

Pupils were asked to draw the line y=x. Pupils needed to be walked through opening a new document and choosing graphs and geometry as it is the first time they have used TI-Nspire.

Q. Can they now draw a parallel line to that, what about a line parallel to y=2x, y=5x+3?

Discuss the rule for parallel lines and formalize understanding by writing an explanation – share these and discuss how good they are – could they be improved?

TI-Nspire Handhelds and software

Main Activity

1. Open a new page
2. Now investigate finding a perpendicular line to y=x (pupils should be quite quick to get to y=-x)
3. Challenge pupils - how can you prove to me it's perpendicular?
4. Take pupils through measuring the angle between the two lines
5. Encourage pupils to then change f1(x) and f2(x) to avoid having to re-measure
6. Show pupils the option of moving the lines to where they want them and looking at how the equation has changed.
7. Pupils then encouraged to explore perpendicular lines to other equations e.g. y=2x
8. Ensure pupils consider examples when the intercept is not 0.

Differentiation

Q. Can pupils write a description about the equation of a perpendicular line for another pupil to follow?

Q. Can they write it using mathematical language?

Plenary

- Collect findings on the whiteboard – table of results, what do you notice?
- Come up with a formal 'rule' for finding the equation perpendicular to a line (use those written by pupils who have got onto extension work)

Homework

Assessment

- Individual and whole class questions and answers and work produced.
- 'Rules' and explanations written and shared

Evaluation

Q. What did you want the pupils to learn?

A. Can you give an equation for a line that is parallel to the line y=2x-3? And one that is perpendicular?

Q. What activity did you choose (or develop) and what mathematical learning took place?

A. Pupils started with a blank graphs and geometry page and were then guided by the teachers instructions and questioning. Pupils were reminded of the form of the equation for a straight line with the accompanying vocabulary. Pupils could explain how to find equations of parallel and perpendicular lines and generate these for specific examples. There was discussion about *f(x)=* notation instead of *y=* explored ideas about y being dependent on x.

Q. How did you introduce the activity?

A. I asked pupils to draw the line y=x and experiment drawing lines until they were parallel and perpendicular.

Q. What were students' initial reactions/questions?

A. Pupils were impressed by the handhelds – especially when they were able to measure the angle between two lines and move a line so that the function changed for them. There were a few issues grabbing the line but very few in comparison to lessons with younger pupils.

Q. Approximately how many of the students could develop strategies to fully pursue the activity with little or no guidance from you?

A. All pupils could do the basics that were required (drawing graphs, measuring angles) but all pupils needed guidance on 'tricks' to save time.

Q. What, if any, guidance did you have to give to the other pupils?

A. I highlighted the advantage of editing functions already entered rather than drawing new functions to save having to repeatedly measure angles.

Q. How did the activity enable pupils to take more responsibility for their mathematical learning?

A. They explored the problem themselves. Another option would have been to draw the graphs by hand which would not have been possible due to time restraints for a fast track group.

Q. Can you give a brief summary of the pupils' work/conclusions?

A. All pupils drew various graphs on the handhelds and discussed their findings with each other informally.
Most pupils were able to verbalise their findings and some were then able to write down rules and explanations with little support – all pupils did this with support.

Q. What aspect(s) of the idea would you use again?
A. Pupils appreciated the ability to move the line on the screen and then be told the equation of the new line.

Q. What changes would you make?
A. It would have been useful to have accompanying resources for pupils to record their graphs and note findings. A PowerPoint or SMART Board file would be useful for teachers less confident with the use of the TI-Nspire.

Q. Were there any other observations or comments?
A. Year 10 high ability pupils were much better at using the handheld in general than the low ability year 8 group I have used it with in the past. They were able to navigate themselves around the handheld menus and file systems with little support.

Q. In your view, did the use of TI-Nspire enhance the mathematical understanding of the pupils? If yes, what evidence would you use to support this?
A. Yes, it allowed pupils to explore the problem for themselves quickly and efficiently so the focus was on the intended learning rather than issues with drawing graphs that could have occurred otherwise.

Feedback from learners

Q. Did you enjoy the lesson?
A. Yes, it was good to use computers in class, and we liked 'playing around' with graphs.

Q. What did you like about TI-Nspire?
A. We liked being able to move lines on graphs and make notes on the 'calculator'

Q. How was the lesson different for you as a pupil?
A. We were able to explore more independently

Evaluation of learners' mathematical activity

		Key process	**Example**
Representing	1	identify the mathematical aspects of the situation or problem	Needed to identify properties of straight line graphs
	2	choose between representations	
	3	simplify the situation or problem in order to represent it mathematically using appropriate variables, symbols, diagrams and models	Generalised from specific examples to a general rule. Ignored the intercept as it wasn't important.
	4	select mathematical information, methods and tools for use	
Analysing	1	make connections within mathematics	
	2	use knowledge of related problems	Y=mx+c
	3	visualise and work with dynamic images	Moved the straight line on the graph
	4	look for and examine patterns and classify	Plenary included a table of results to look for connections between the original equation and the perpendicular one.

	5	make and begin to justify conjectures and generalisations, considering special cases and counter examples	Y=x to y=-x led some pupils to believe y=2x would go to y=-2x. Y=2x to y=0.5x led some pupils to believe y=5x would go to y=5/4x (noticed divide by 4)
	6	explore the effects of varying values and look for invariance	Tried different values for gradient
	7	take account of feedback and learn from mistakes	Investigation style – trial and improvement
	8	work logically towards results and solutions, recognising the impact of constraints and assumptions	
	9	appreciate that there are a number of different techniques that can be used to analyse a situation	
	10	reason inductively and deduce	
Use appropriate mathematical procedures	1	make accurate mathematical diagrams, graphs and constructions on paper and on screen	Graphs on screen, measured angles
	2	calculate accurately, using a calculator when appropriate	
	3	manipulate numbers, algebraic expressions and equations and apply routine algorithms	
	4	use accurate notation, including correct syntax when using ICT	Discussion about f(x)= and y=
	5	record methods, solutions and conclusions	Recorded conclusions on handheld and in exercise books. Saved files on handheld.
	6	estimate, approximate and check working	
Interpreting and evaluating	1	form convincing arguments based on findings and make general statements	Pupils were asked to convince their partner and/or the teacher
	2	consider the assumptions made and the appropriateness and accuracy of results and conclusions	Measurements not always exact e.g. 90.34...° between y=2x and y=-0.49x
	3	be aware of strength of empirical evidence and appreciate the difference between evidence and proof	Measured the angle to show it was perpendicular, made general statements
	4	look at data to find patterns and exceptions	
	5	relate findings to the original context, identifying whether they support or refute conjectures	
	6	engage with someone else's mathematical reasoning in the context of a problem or particular situation	Discussion between pupils, some chose to work together in pairs on just one of their handhelds at various points within the lesson.
	7	consider whether alternative strategies may have helped or been better	
Communicating and reflecting	1	communicate findings in a range of forms	Function form and graphs. Discussed and then formalised findings in written form.
	2	engage in mathematical discussion of results	
	3	consider the elegance and efficiency of alternative solutions	
	4	look for equivalence in relation to both the different approaches to the problem and different problems with similar structures	
	5	make connections between the current situation and outcomes, and ones they have met before	Y=mx+c, connected rules for parallel and perpendicular lines (focus on gradient).

Adapted from QCA (2007) Draft Programme of Study: Mathematics (Key Stage 3) [online at http://www.qca.org.uk/secondarycurriculumreview/subject/ks3/mathematics/index.htm]