

University of Nottingham  
Lyon, April 2015

# Research focus

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The research focuses on the **use of iPads** in mathematics lessons and how they can be used to facilitate or enhance formative assessment.

The lessons in this phase all involved some **paired work** using iPads (or laptops) but with different software and mathematical topics.

# Formative assessment

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What is the impact from using the technology when:

- Building on student's prior knowledge;
- Identifying and responding to students' conceptual difficulties;
- Using questioning;
- Increasing student collaboration;
- Enabling students to become assessors.

# Research questions (1)

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- How do teachers **process** formative assessment data from students using a range of technologies?
- How do teachers **inform their future teaching** using such data?

## Research questions (2)

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- How is formative assessment data used by students **to inform their learning trajectories**?
- When technology is positioned as a learning tool rather than a data logger for the teacher, **what issues does this pose for the teacher** in terms of their being able become more informed about student understanding?

# The research plan

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The research involves:

- **Three schools** and three teachers in each school;
- **Three lessons** in each school, to be developed and taught by each teacher;
- Observation or video-recording of each lesson in **three phases**: March, May and June 2015.

# The schools

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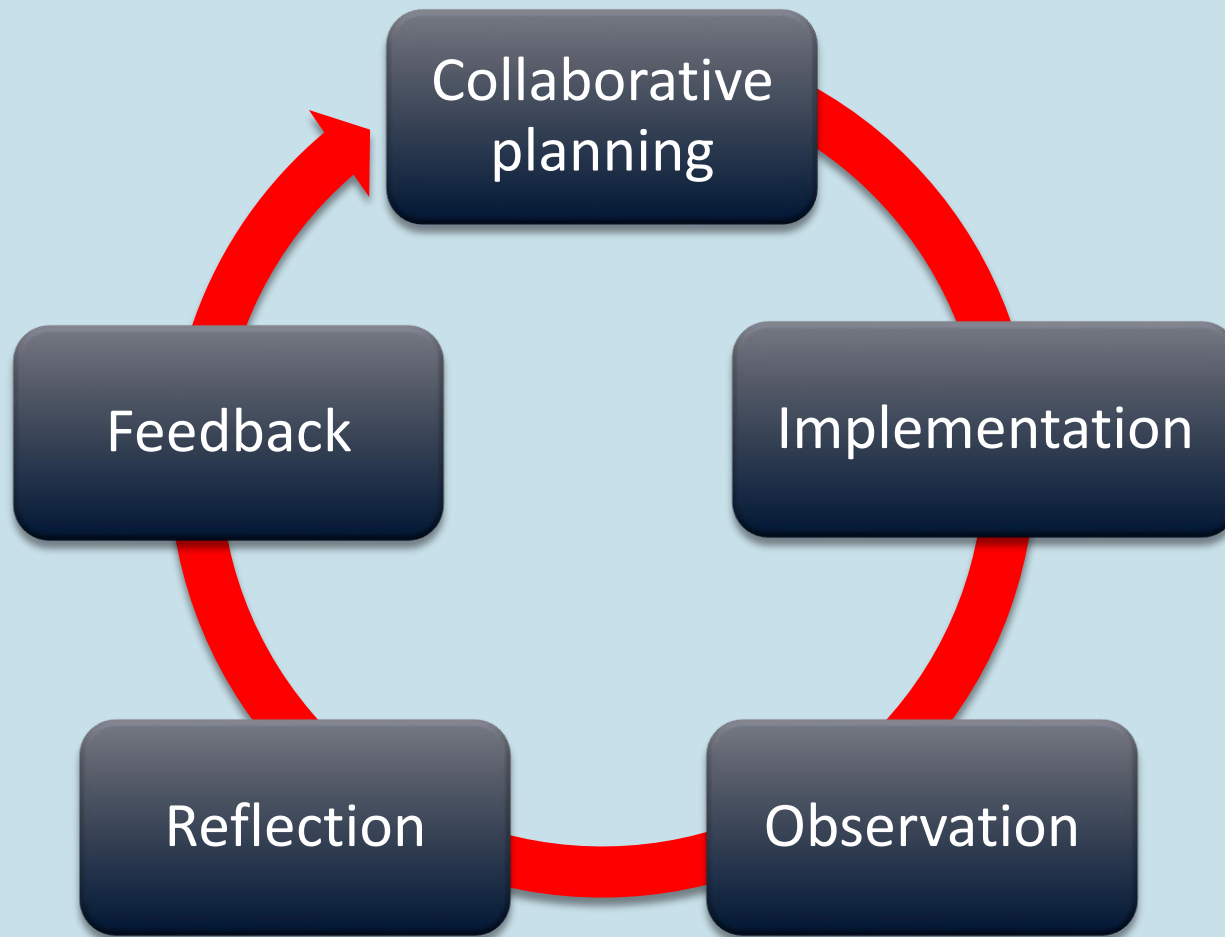
**Trinity Catholic School** in the city of Nottingham for pupils aged 11-18 years.

**De Ferrers Academy** in the town of Burton-on-Trent for pupils aged 11-18 years.

**Bagthorpe Primary School** in the village of Bagthorpe is a school for pupils aged 5-11 years.

# The planning cycle

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# Questions for teachers

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- What did you do?
- How was the technology used?
- What were the opportunities for formative assessment?
- How were the opportunities used?
- What have you learned?

## Whole class introduction

Whole class interventions and questioning

Drawing together students' ideas

Student engagement with whole-class discussion

## Framework for analysis of lesson observations

## Return of student work

Providing formative feedback

Student responses to formative feedback

## Individual working time

Monitoring and assisting individual students

Student interaction with teacher during individual work

## Collaborative work

Fostering peer assessment and questioning

Monitoring and assisting individual students

Student interaction with teacher during group work

Student interaction with peers during group work

## Students' evaluation of student work

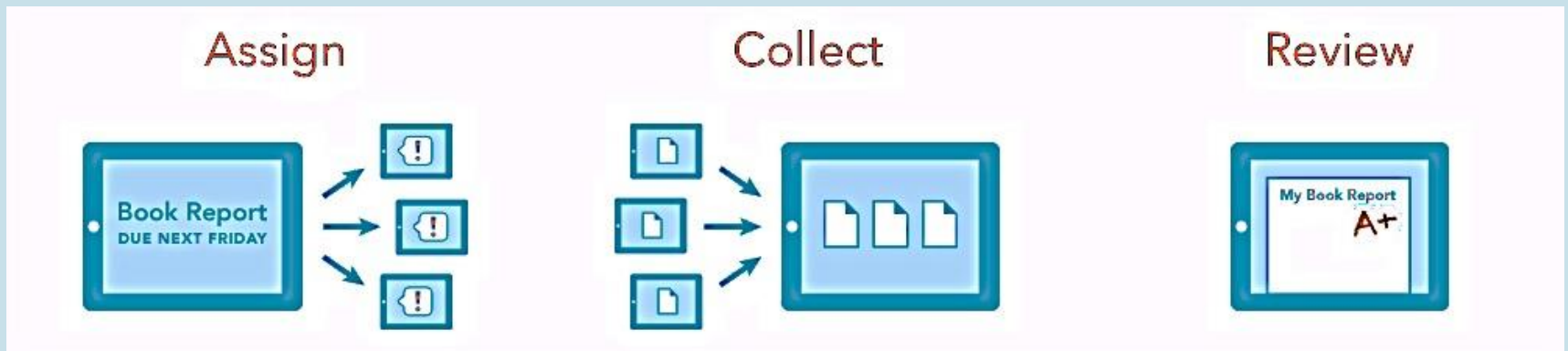
Assessing samples of written student work

Student interaction with teacher during group work

Student interaction with peers during group work

# Lesson 1: distance-time graphs

- Two diagnostic questions to start the lesson;
- Use of *Showbie* to:

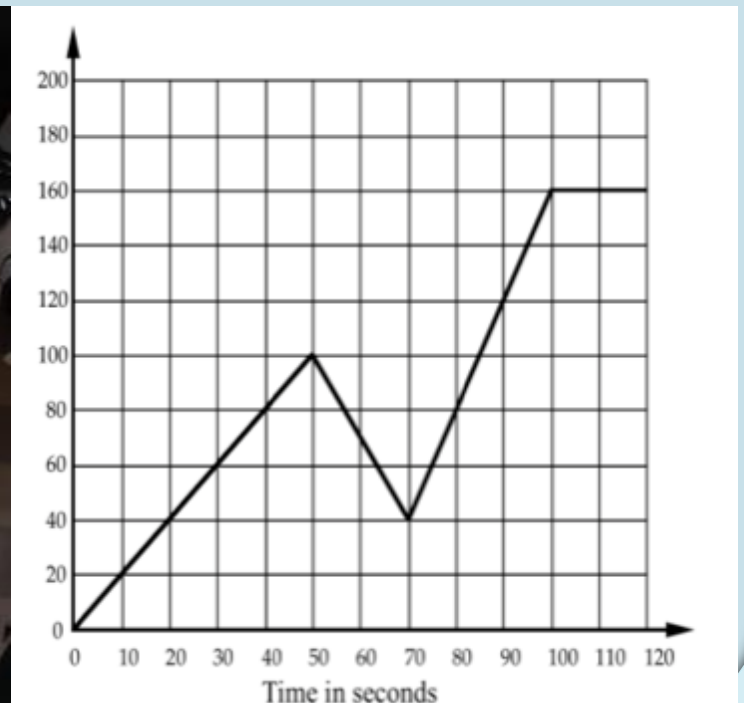


- Selected student work used to discuss and address misconceptions;
- Peer assessment and discussion based on responses to 'mirrored' questions.

# Interpreting a graph

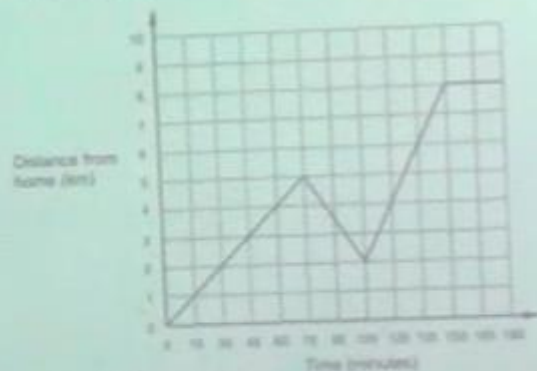
## A walk to the shop...

One day John went for a walk to the shop. The graph shows his walk. Describe what may have happened.



### A walk to the shop...

One day John went for a walk to the shop. The graph below shows his walk. Describe what may have happened.



It took him 1 hour & 15 minutes to walk 5 km. Then he went back 3 km which took him 30 minutes. Then he walked 5 km in 1 hour & 15 minutes. He then stopped at 8 km for 30 minutes.



# Drawing a graph

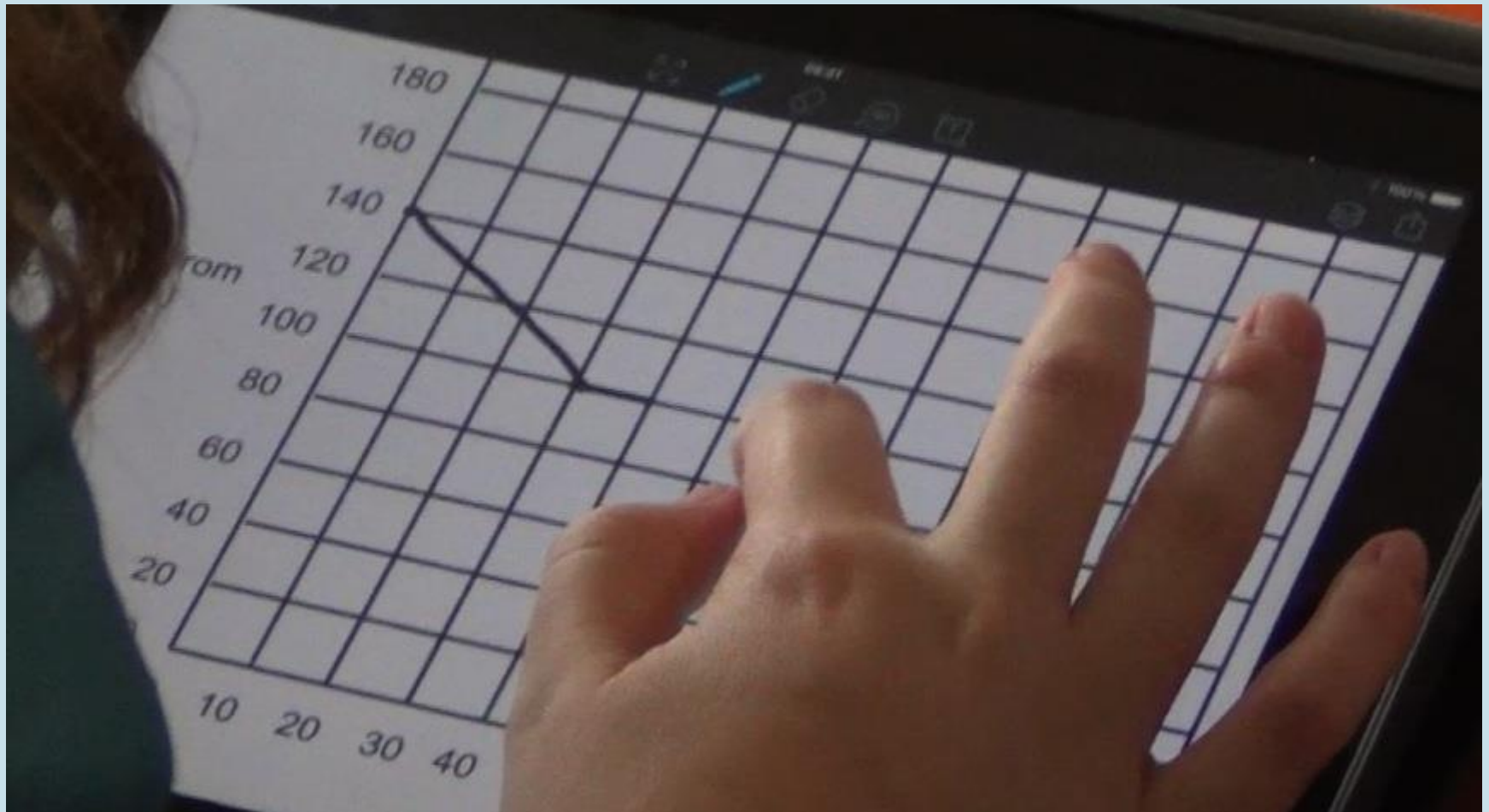
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## A long drive home

Sarah left her friend's house at 5pm. Her drive home was expected to be 140km. She travelled at a constant speed of 80km/h for 30 minutes. She was then stuck in a stationary traffic jam for 10 minutes. The traffic then began moving at a constant speed of 60km/h for 20 minutes. Finally, the traffic cleared and she completed her journey home at a constant speed of 120km/h.

Complete the graph for Sarah's journey.

# Making decisions

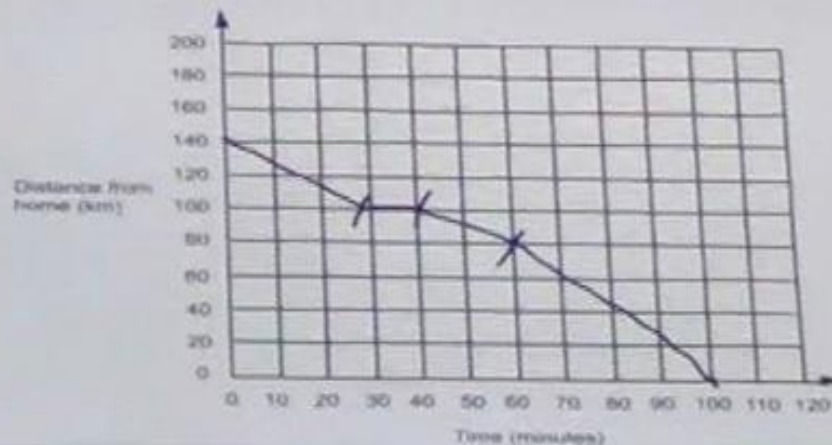




# Completing the graph

Sarah left her friend's house at 5pm. Her drive home was expected to be 140km. She travelled at a constant speed of 80km/h for 30 minutes. She was then stuck in a stationary traffic jam for 10 minutes. The traffic then began moving at a constant speed of 60km/h for 20 minutes. Finally, the traffic cleared and she completed her journey home at a constant speed of 120km/h.

Complete the graph for Sarah's journey.

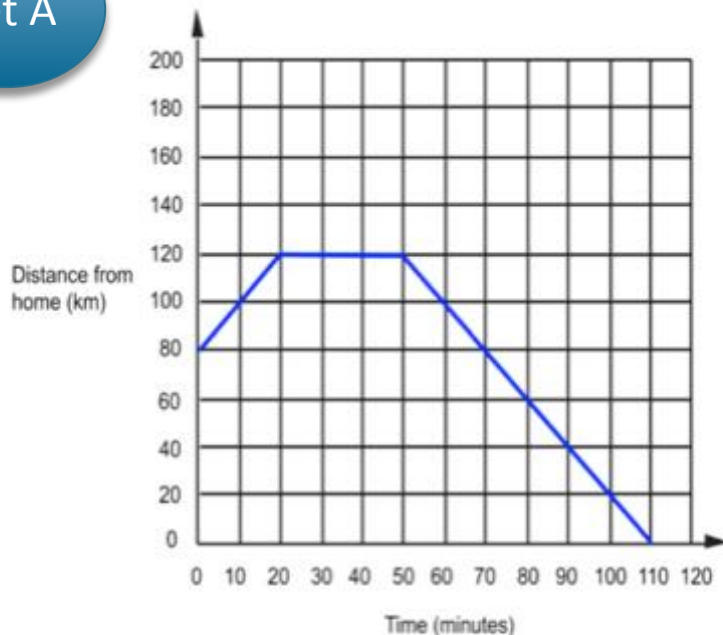




# Mirrored questions:

## Graph to story; Story to graph

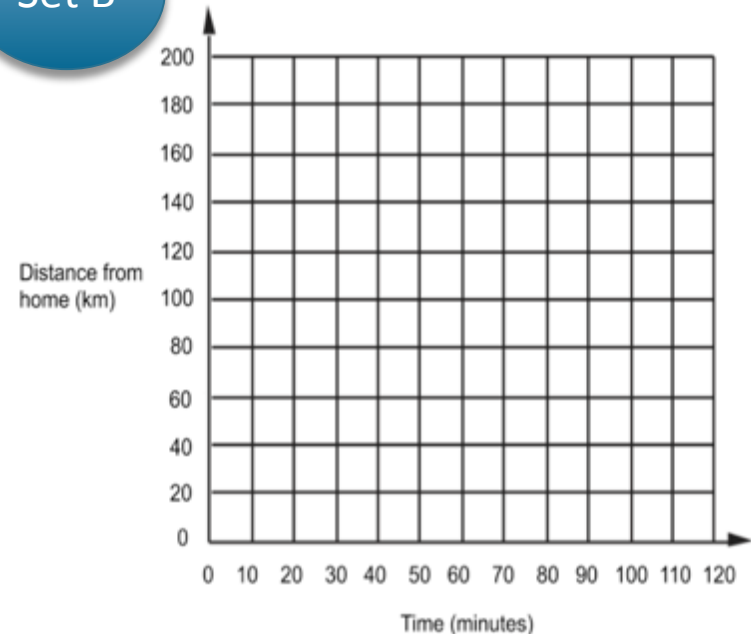
### Set A



Complete the story below from the graph.

James is at his friend's house, which is \_\_\_\_\_ from his house. He travels away from his house to see his Grandma at a \_\_\_\_\_ speed of \_\_\_\_\_ km/h for \_\_\_\_\_ minutes. He stays at his Grandma's house for \_\_\_\_\_ minutes. He then travels home at a \_\_\_\_\_ speed of \_\_\_\_\_ km/h.

### Set B



Complete the graph based on the story below.

James is at his friend's house, which is **80km** from his house. He travels to away from his house to see his Grandma at a **constant** speed of **120 km/h** for **20** minutes. He stays at his Grandma's house for **30** minutes. He then travels home at a **constant** speed of **120 km/h**.

# Peer assessment and discussion

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# Lesson 2: algebraic expressions

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- Diagnostic assessment prior to lesson using [diagnosticquestions.com](http://diagnosticquestions.com);
- Lesson plan adapted in response to the profile of student responses and reasons given;
- Use of *Nearpod* to send, receive and display selected student responses;
- Selected student work used to discuss and address misconceptions.

# Pre-lesson diagnostic questions

<https://www.diagnosticquestions.com>



The screenshot shows the homepage of the Diagnostic Questions website. At the top, there is a navigation bar with links for Questions, Quizzes, Products, Data, About, LOGIN, and REGISTER. Below the navigation bar is a large, dark background image featuring a bookshelf, a keyboard, and an iPod mini. In the center, there is a logo consisting of a circle divided into four quadrants of different colors (green, blue, yellow, and red). Below the logo, the text "Diagnostic Questions" is displayed. Underneath that, the main heading "Identifying, Understanding and Resolving Misconceptions" is shown in a bold, white font. At the bottom, there are four statistics presented in large, colorful numbers, each with a corresponding description below it:

7195	452449	10191	58914
Free Diagnostic Questions	Answers given by our community	Teachers sharing and creating	Students learning together

# Questions devised by teachers



The above two shapes are similar. What is the value of  $x$ ?

- ☐ A) 18 cm    ☐ B) 12 cm  
☐ C) 14 cm    ☐ D) 24 cm

Length, Area and Volume Sc...

12 Questions

4 Likes



2800m = ... m

- ☐ A) 2800m    ☐ B) 0.28m  
☐ C) 0.028m    ☐ D) 2.8m

Units of Measurement

12 Questions

1 Likes



$x$      $y$      $z$

Which of the following is a good next step to make  $z$  the subject of the formula?

- ☐ A)  $\frac{3z}{x} = \frac{6}{y} - 1$     ☐ B)  $\frac{3z}{xz} = \frac{6z}{yz} - \frac{z}{z^2}$   
☐ C)  $\frac{x}{3} = \frac{y}{6} - \frac{z}{1}$     ☐ D)  $\frac{3z}{x} = \frac{6z}{y} - 1$

Rearranging Formula: Step-b...

7 Questions

5 Likes



$$\begin{aligned} x^2 + y^2 &= 19 \\ y &= x + 5 \end{aligned}$$

Which of the following is a correct next step to solve these simultaneous equations?

- ☐ A)  $x^2 + x^2 + 25 = 19$     ☐ B)  $x^2 + y^2 = 19$   
 $y^2 = x^2 + 25$   
☐ C)  $x^2 + (x + 5)^2 = 19$     ☐ D)  $x + y = \sqrt{19}$   
 $y = x + 5$

Quadratic Simultaneous Equ...

$$-2 - -6 =$$

- ☐ A) -8    ☐ B) 8  
☐ C) -4    ☐ D) 4

11a6 revision quiz 1

Show  $x > -1$  on a number line

- A)   
 B)   
 C)   
 D)

Inequalities Collection 1

# Choices for students

$$-2 - -6 =$$

A

-8

B

8

C

-4

D

4

A

B

C

D





# Student responses

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$$-2 - -6 =$$

Two minuses make a plus



A

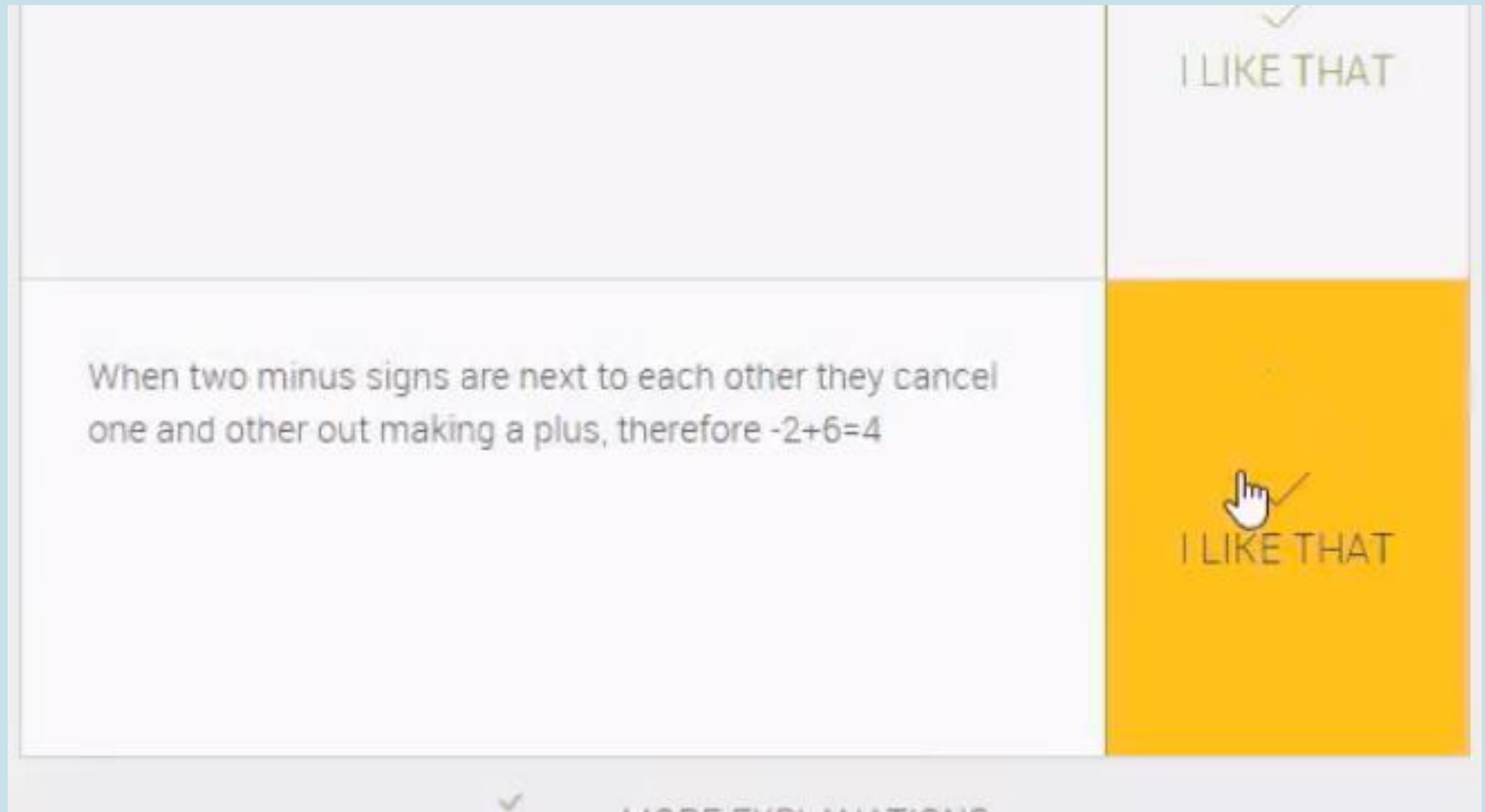
B

C

D



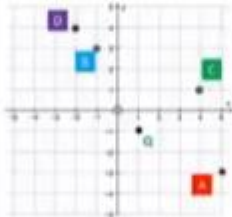








# Options for students

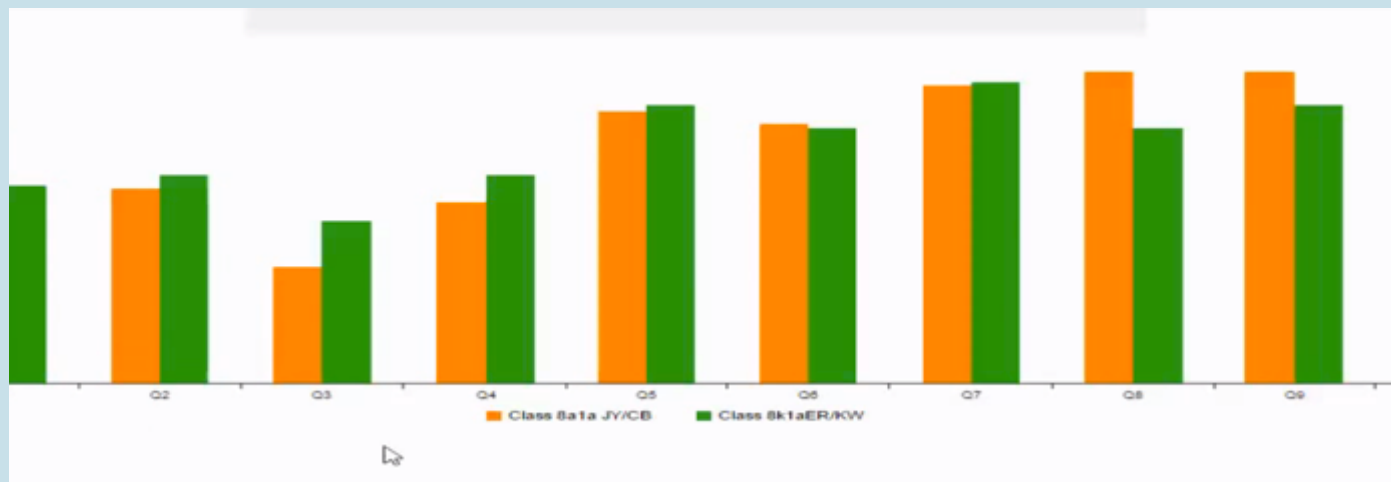




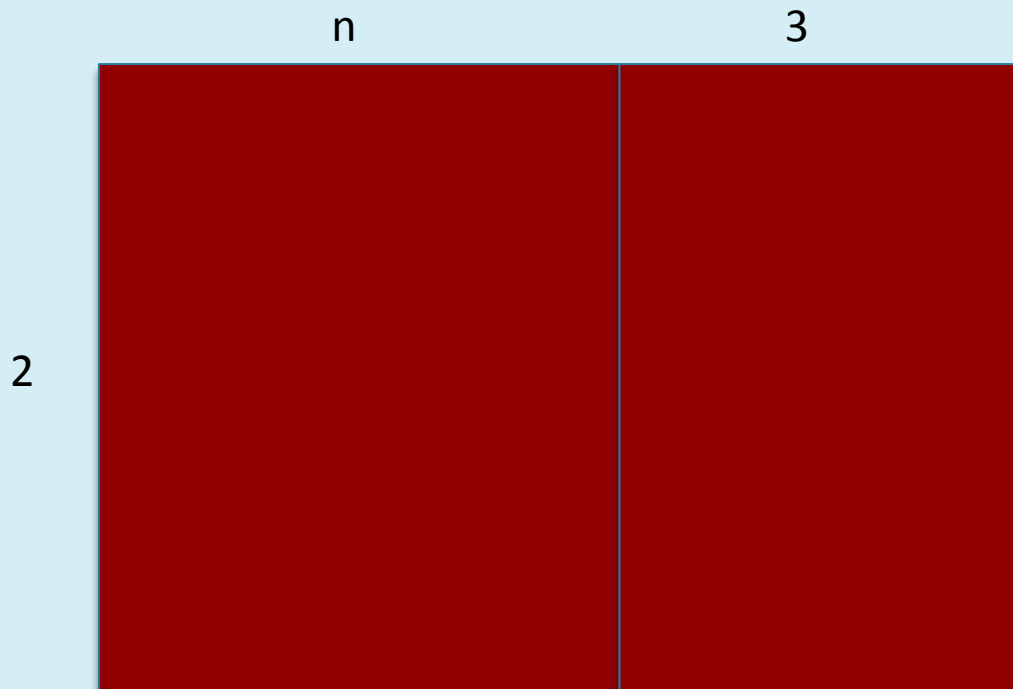
# Teacher overview

5	<p>Which of these shows an incorrect equivalent fraction? (Filled-in numbers are shown in red)</p> <p><math>\frac{3}{5} = \frac{2}{10}</math>   <math>\frac{3}{5} = \frac{15}{25}</math>   <math>\frac{3}{5} = \frac{21}{35}</math>   <math>\frac{3}{5} = \frac{30}{50}</math></p> <p>(A)   (B)   (C)   (D)</p>	 	22	Try Again   View Explanations
6	 <p>Point C is translated by the vector <math>\begin{pmatrix} -2 \\ 4 \end{pmatrix}</math>. Where does the point go?</p>	<p>Charlotte Cleary - It goes two left (-2) and 4 up (4) and it gets to point b.</p>   	22	Try Again   View Explanations
7	<p>A boat is travelling on a bearing of 190°. In what direction is it travelling?</p> <p>(A) West (B) East (C) North (D) South</p>	  	22	Try Again   View Explanations

# Class profiles



Write down an expression for the  
area of the rectangle



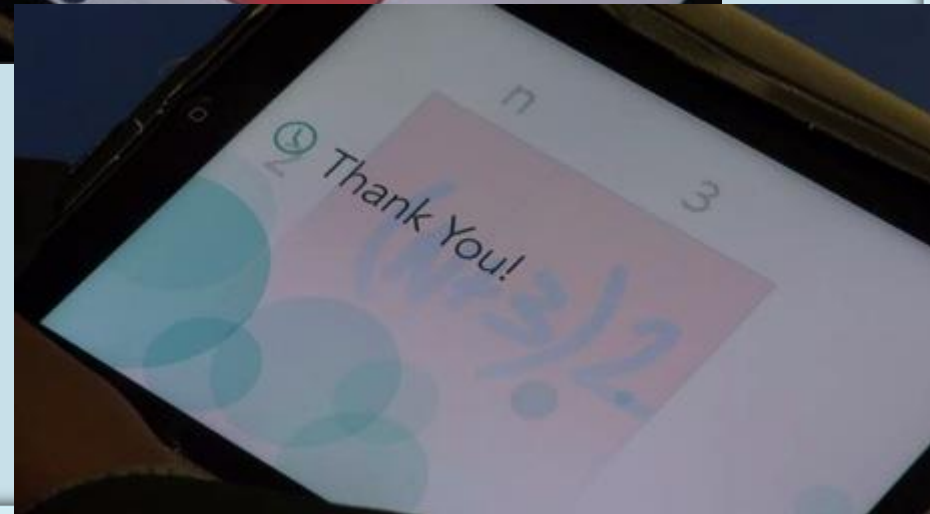


Receiving questions

Working out  
answers

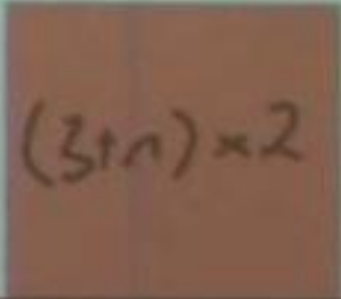


Sending responses



# Class discussion


wing



A diagram of a Chi-shaped structure, consisting of a vertical bar of height 2 and a horizontal bar of width 3. The total width is labeled as  $n$  and the total height as 3. The handwritten formula  $(3+n) \times 2$  is written across the structure.

$$2 \quad (3+n) \times 2$$

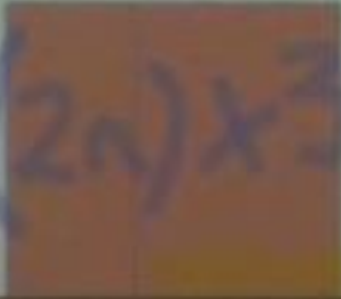
Chi



A diagram of a Victoria-shaped structure, consisting of a vertical bar of height 2 and a horizontal bar of width 3. The total width is labeled as  $n$  and the total height as 3. The handwritten formula  $(3+n) \times 2$  is written across the structure.

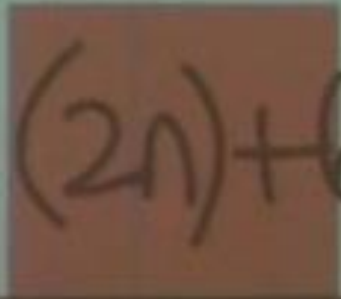
$$2 \quad 3 \quad (3+n) \times 2$$

Victoria



A diagram of a Chi-shaped structure, consisting of a vertical bar of height 2 and a horizontal bar of width 3. The total width is labeled as  $n$  and the total height as 3. The handwritten formula  $(2n) \times 3$  is written across the structure.

$$2 \quad (2n) \times 3$$



A diagram of a Victoria-shaped structure, consisting of a vertical bar of height 2 and a horizontal bar of width 3. The total width is labeled as  $n$  and the total height as 3. The handwritten formula  $(2n) + 6$  is written across the structure.

$$2 \quad (2n) + 6$$



# Lesson 3: Tessellation

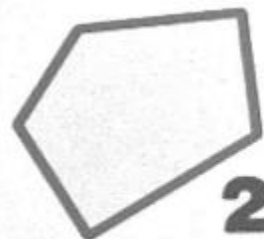
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- Students discuss common shapes and their properties with the teacher;
- Students make predictions of shapes that will tessellate;
- Students use the “Tessellation creator” app to test their predictions;
- Students explore tessellations of two or more shapes;
- Students view, assess and comment on work by their peers.





**1**



**2**



**3**



**4**



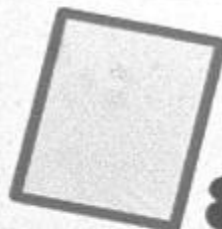
**5**



**6**



**7**



**8**



**9**



**10**



**11**



**12**



**13**



**14**



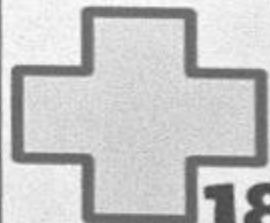
**15**



**16**



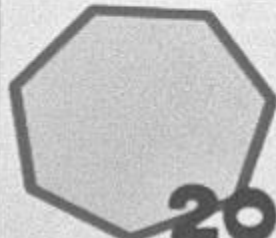
**17**



**18**



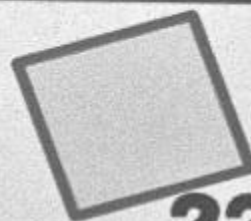
**19**



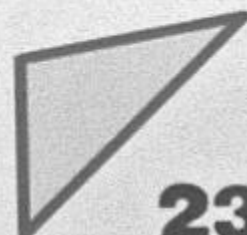
**20**



**21**



**22**



**23**



**24**



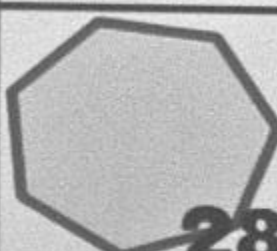
**25**



**26**



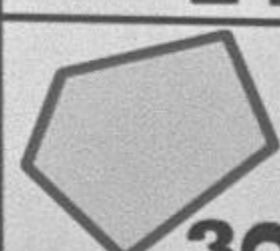
**27**



**28**

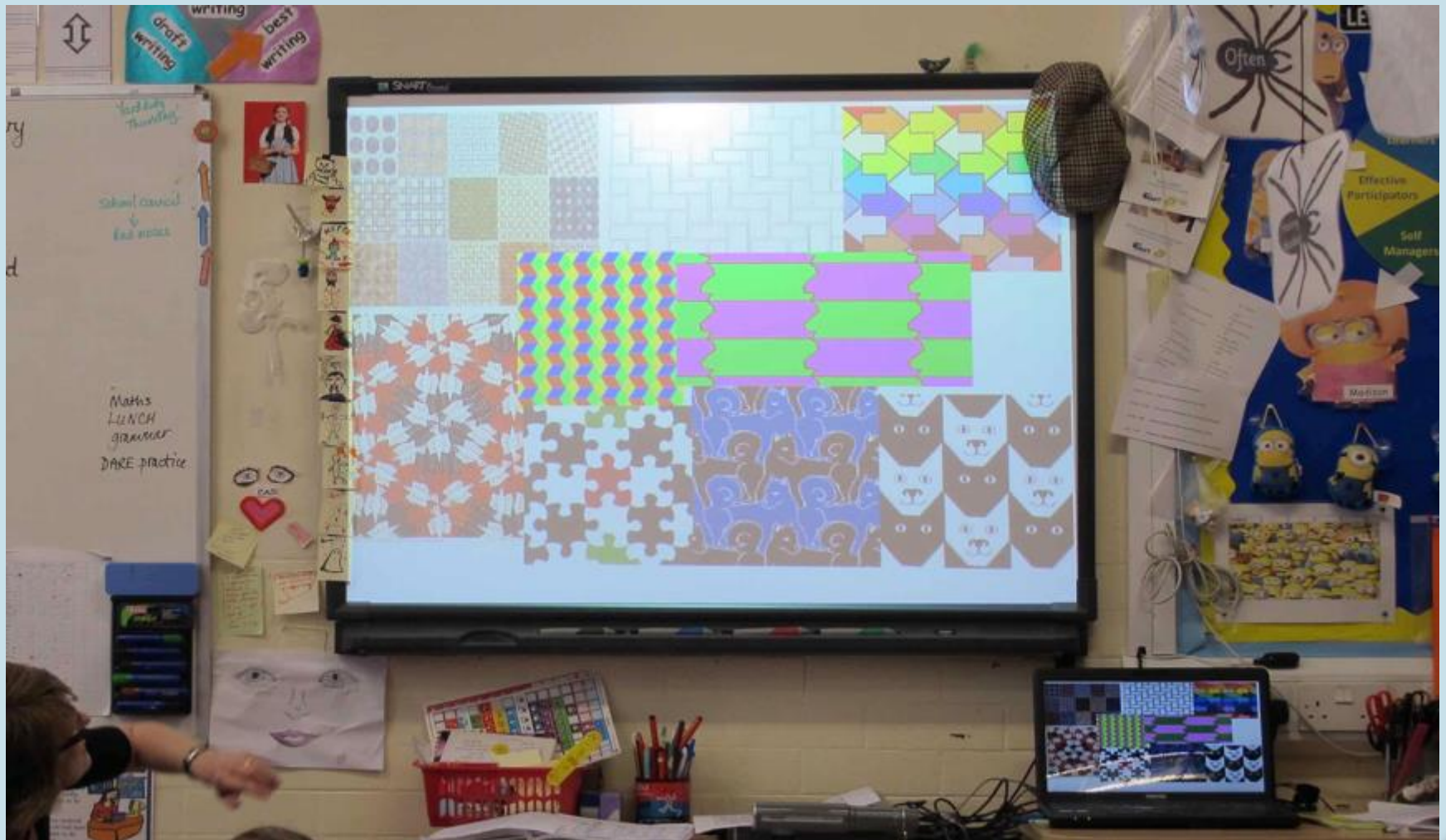


**29**



**30**

# Discussing tessellation



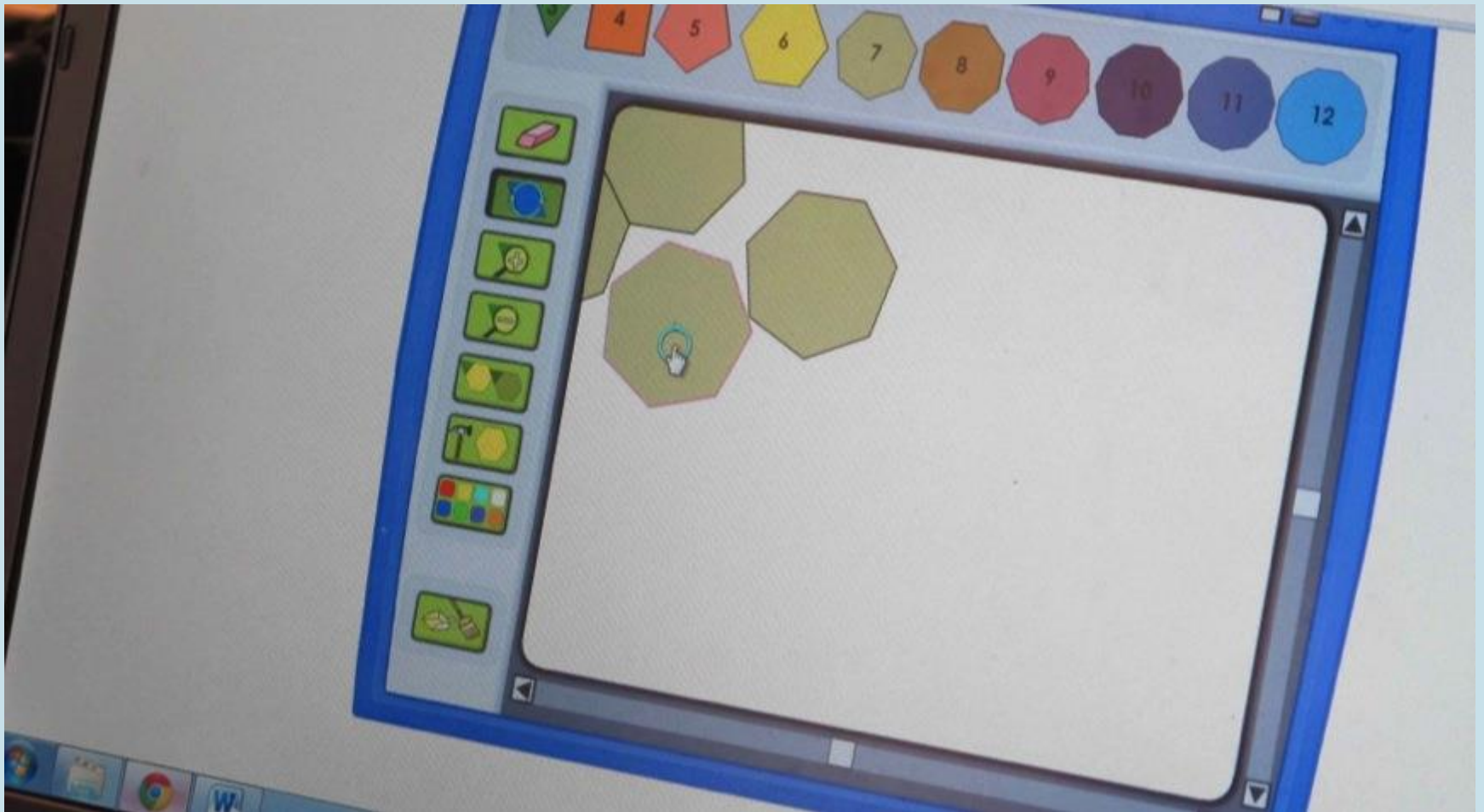


# Making predictions

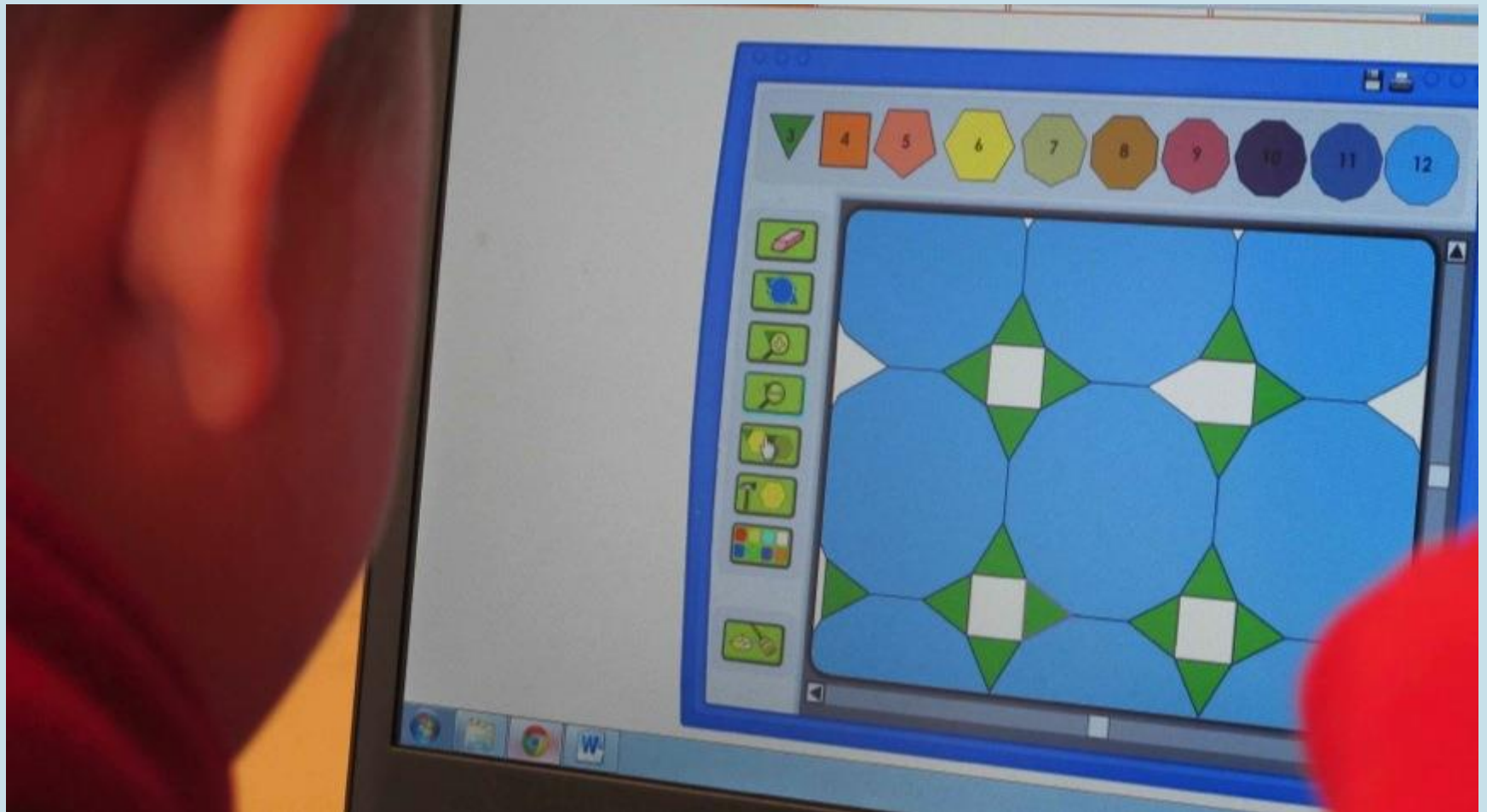
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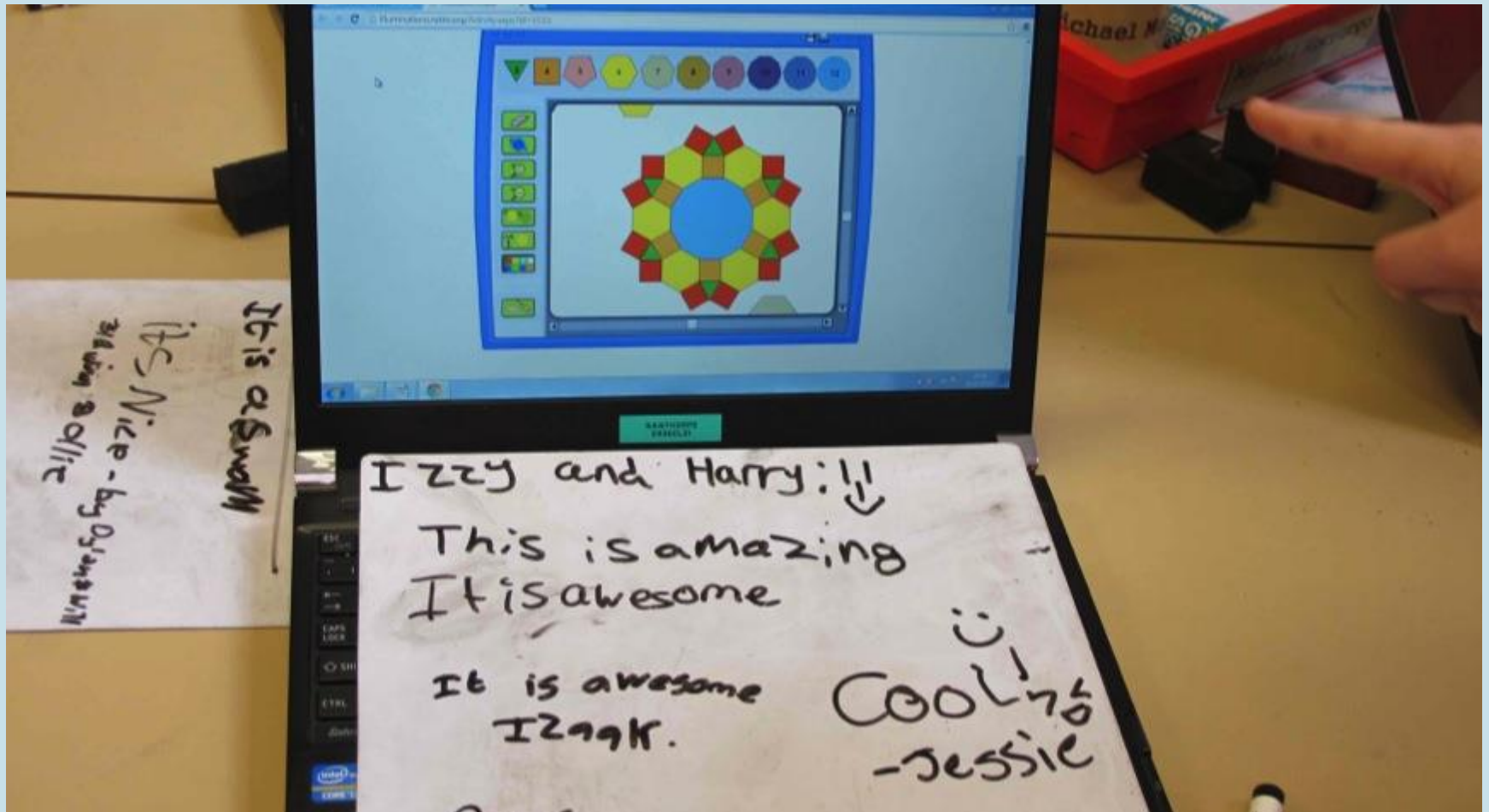
# Testing the predictions



# Exploring further

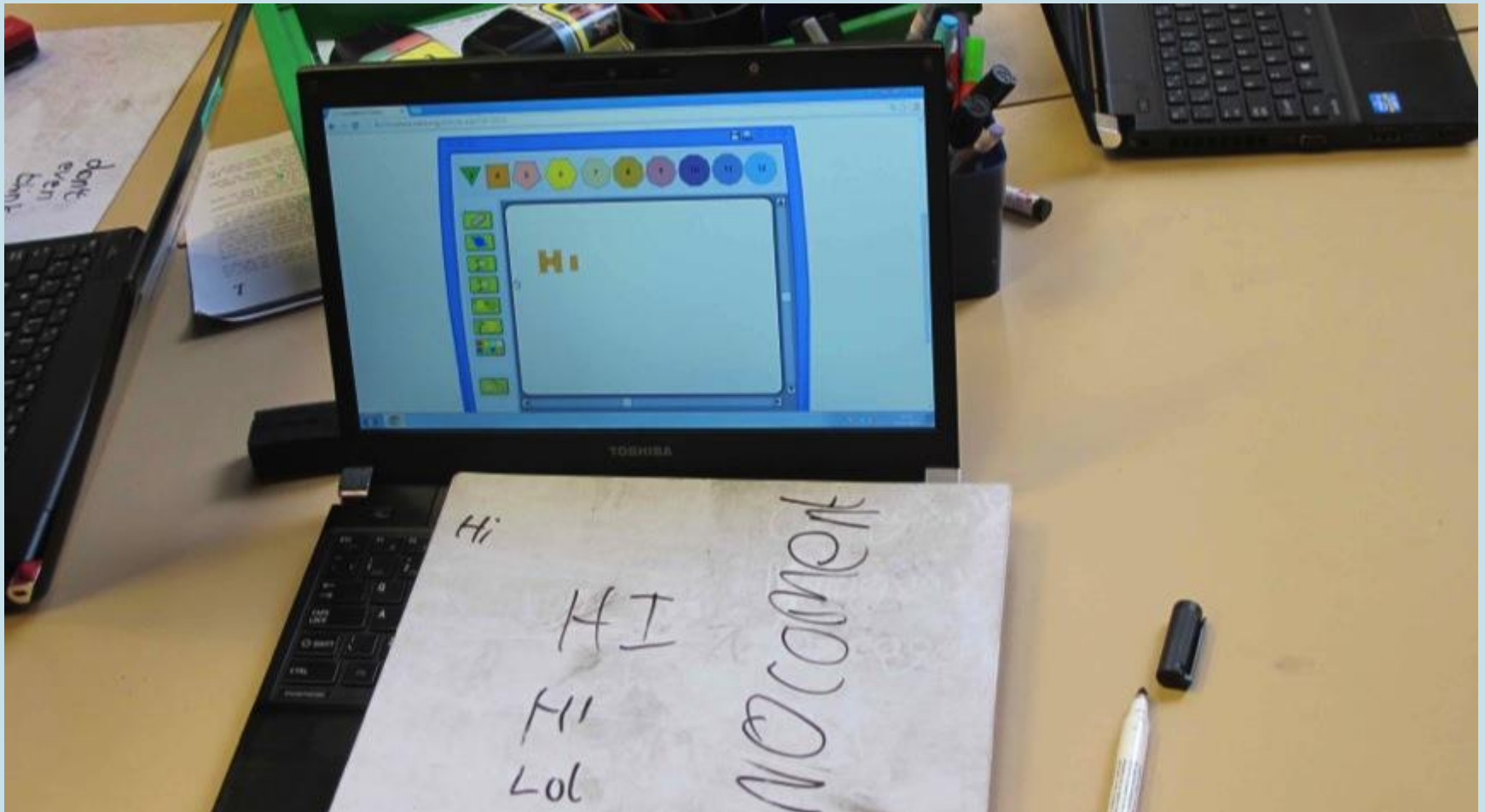


# Peer assessment





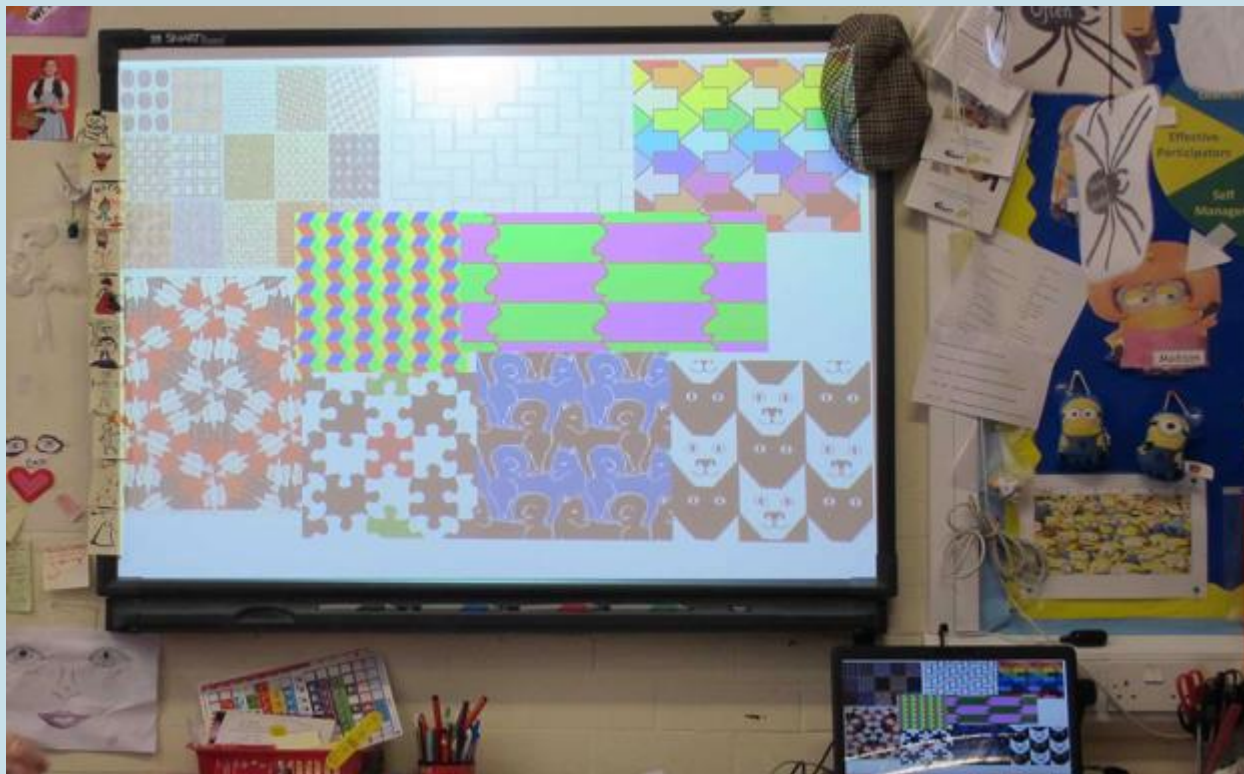
# The limitations of technology?



# The role of technology (1)

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A direct replacement for paper-based methods of formative assessment?



# The role of technology (2)

A replacement with the same function but additional benefits?

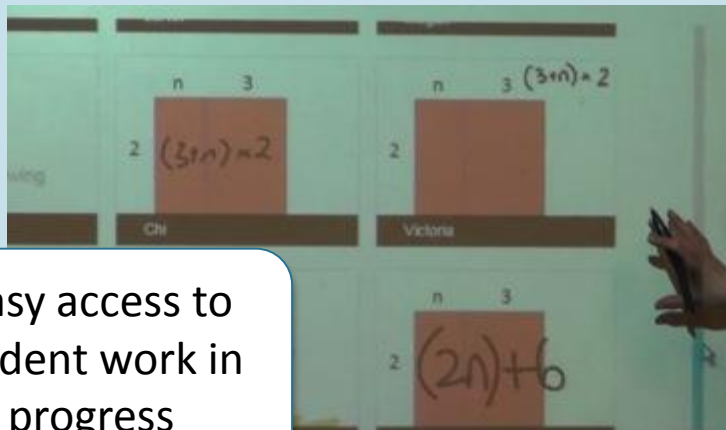
Ease and speed of obtaining class profiles



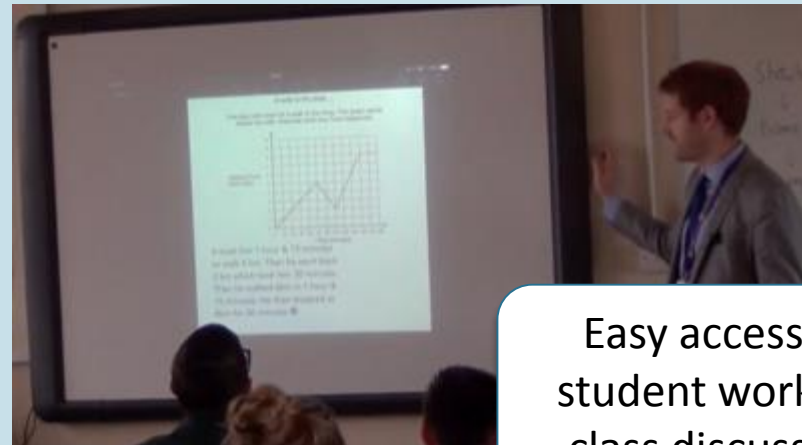
Less time drawing so more time for student discussion



Easy access to student work in progress

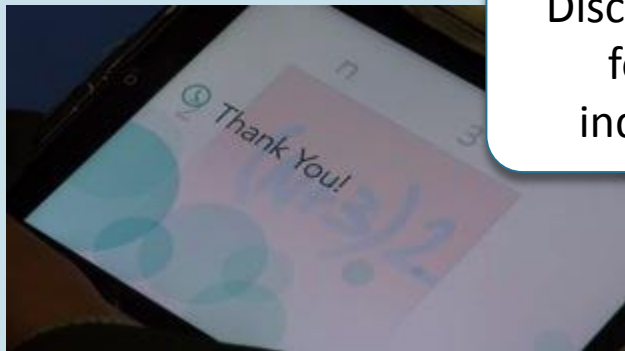


Easy access to student work for class discussion

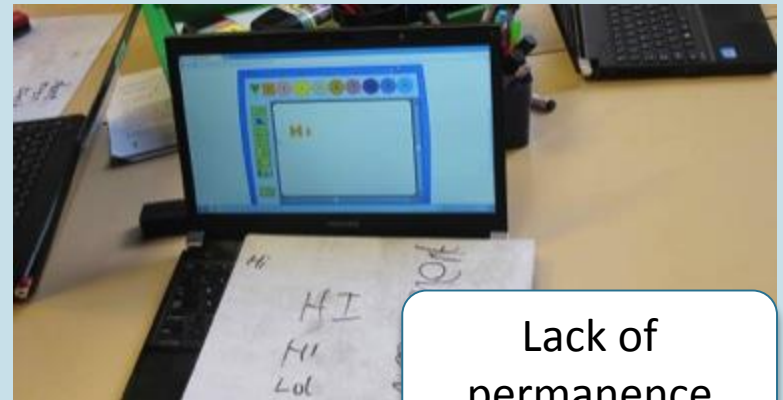


# The role of technology (3)

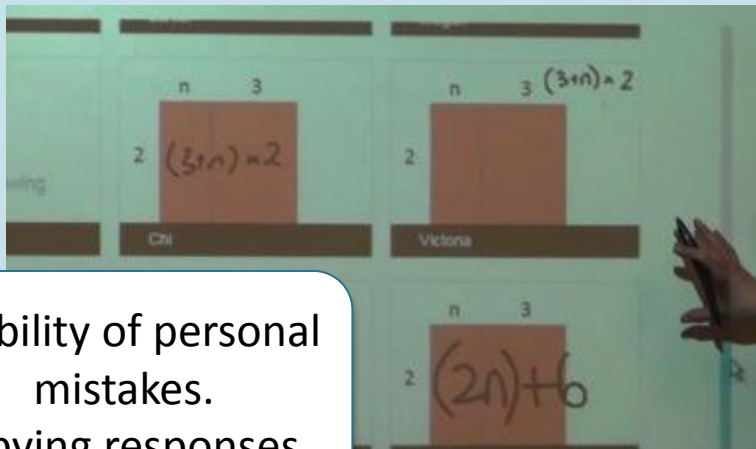
A replacement with the same function but some disadvantages?



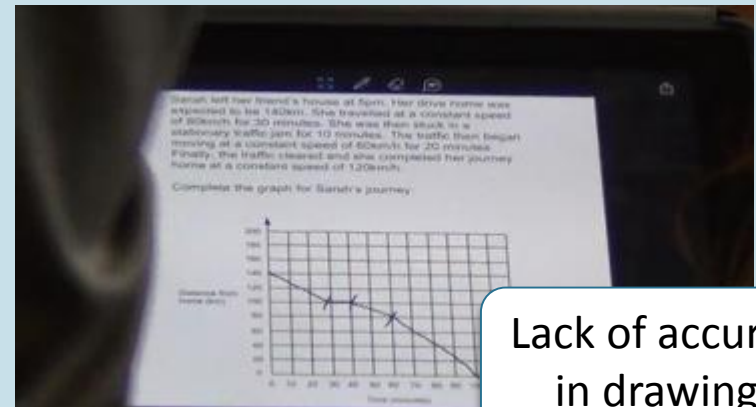
Discontinuity  
for the  
individual



Lack of  
permanence



Visibility of personal  
mistakes.  
Copying responses.



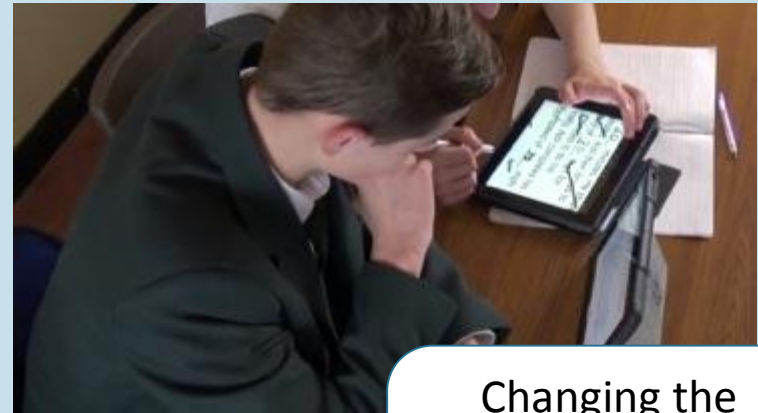
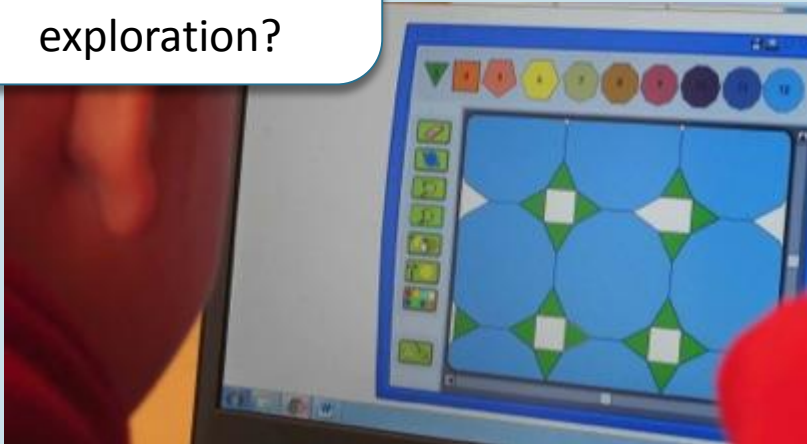
Lack of accuracy  
in drawing



# The role of technology (4)

A tool that significantly changes the process of formative assessment?

Presenting new questions and areas for exploration?



Changing the nature of peer assessment and discussion?

## Whole class introduction

- Whole class interventions and questioning
- Drawing together students' ideas
- Student engagement with whole-class discussion

Where is the technology is used?

## Return of student work

- Providing formative feedback
- Student responses to formative feedback

Where are the critical points?

## Individual working time

- Monitoring and assisting individual students
- Student interaction with teacher during individual work

## Collaborative work

- Fostering peer assessment and questioning
- Monitoring and assisting individual students
- Student interaction with teacher during group work
- Student interaction with peers during group work

What is the impact on the formative assessment process?

## Students' evaluation of student work

- Assessing samples of written student work
- Student interaction with teacher during group work
- Student interaction with peers during group work

Technology	Use	School	Process	Purpose	Teacher assessing <i>or</i> student assessing	Type
iPad	Questions are sent to students electronically to complete.	DF	Teacher gains overview of correct responses and student working.	Diagnostic work.	Teacher	Replacement with benefit of speed and easy access.
iPad and IWB	Student work is completed on iPads displayed for group and discussion.	DF	Facilitates group discussion.	Teacher selects student work that leads to useful class discussion about misconceptions.	Both	Replacement with benefit of easy access.
iPad	Students work in pairs on iPads.	DF	Replacement	Students engage in peer assessment and discussion.	Students	Replacement.
iPad	Students display and share solutions to 'mirrored' questions.	DF	Replacement	Peer assessment and discussion.	Students	Replacement or different process.

# Initial conclusions

In some cases the technology:

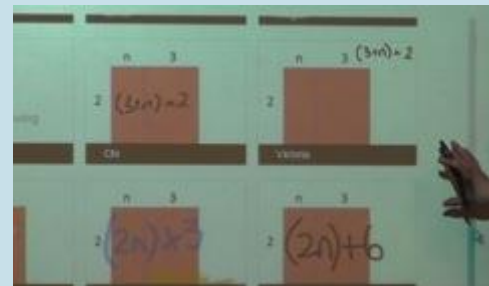
1. Made information on student performance readily accessible by processing and summarising data.

e.g. class profiles



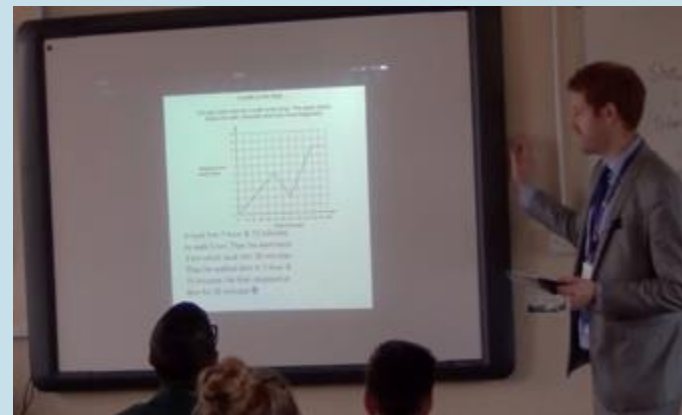
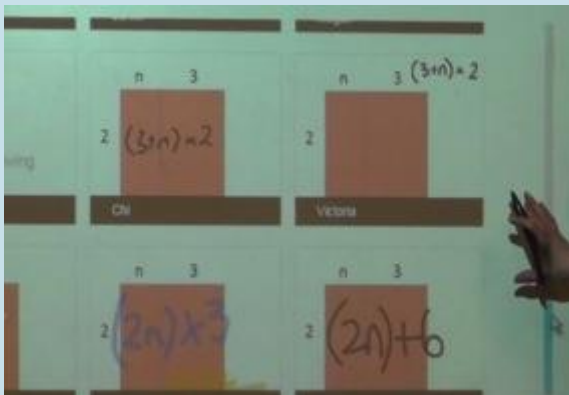
2. Made information on individual students' progress easily accessible at frequent intervals during lessons.

e.g. *Showbie*, *Nearpod*.



# Interim conclusions

3. Allowed the teacher to select and display appropriate student work in order to discuss and address misconceptions.  
e.g. *Nearpod*, *Showbie*, or connecting individual iPads to the Interactive White Board.



# Interim conclusions

4. Saved time for students when drawing graphs or shapes that could be used for other purposes, e.g. comparing, discussing, exploring.



5. Opened up new areas of questioning.

