Videos, Hints and Misconceptions: Numbas as a Support Tool in SPIRIT Maths

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www.spiritmaths.com

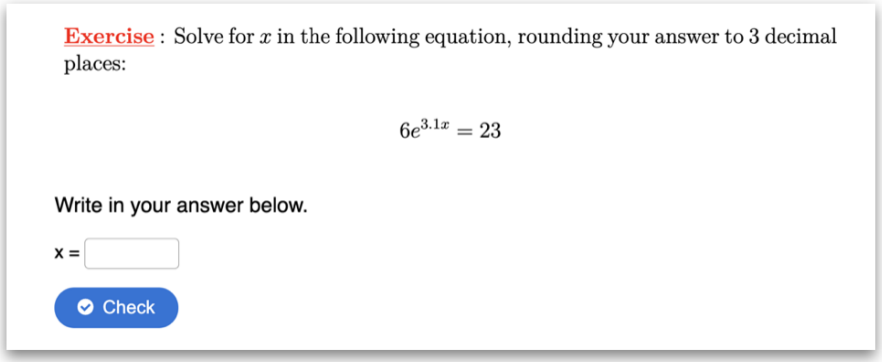
SPIRIT Maths

SPIRIT Maths (Students' Perceptions Informing and Redefining Innovative Teaching of Mathematics in Higher Education

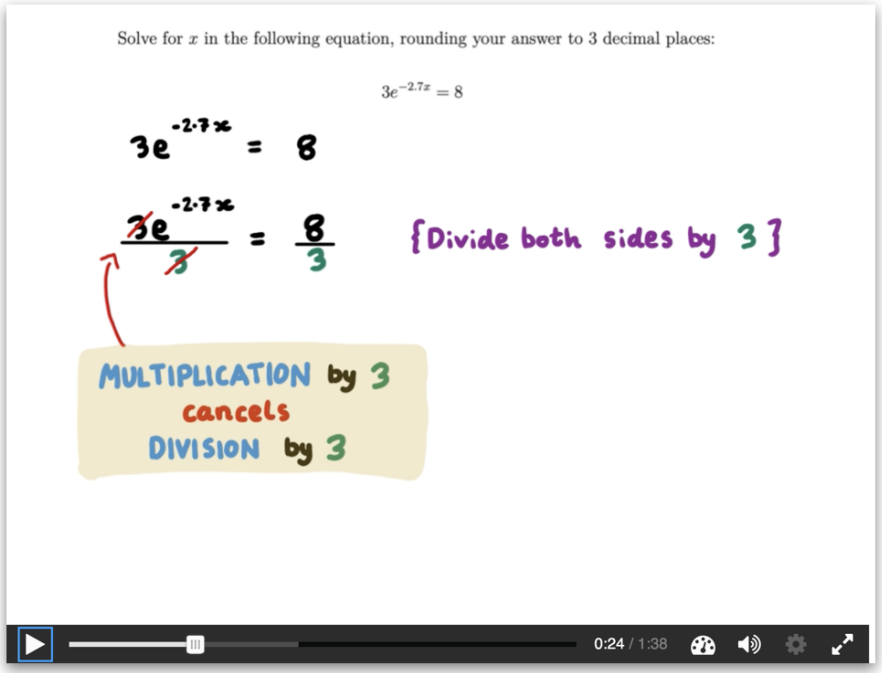
- Established in the 2019/2020 academic year
- Digital resources to support students' learning and encourage student engagement
- Survey to assess students' attitudes
- Results informed the development of resources

Interlinked Digital Resources

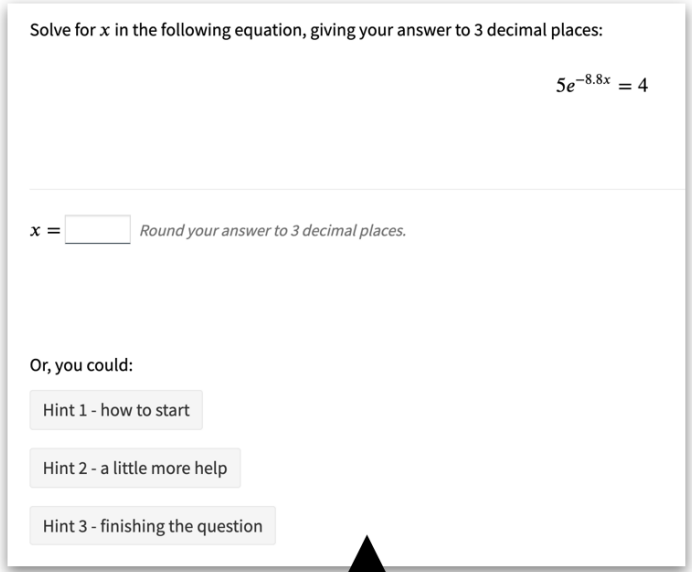
1. H5P: Work out your answer and check if it's correct.



2. Video: Watch a video of a worked solution.



3. NUMBAS: Practise more questions of this type, get hints and instant feedback.



Numbas Questions

- ❑ Randomised variables
- ❑ Fully worked solutions
- ❑ Sequential hints
- ❑ Customised feedback

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Randomised Variables

Find the value of x given information about the mean

The mean of $2, 2, 1, 2$ and x is 2.8, find the value of x.

$x =$ ____

Show steps *(You will lose **1** mark.)*

Submit answer **Score: 0/1** Try another question like this one Reveal answers

Randomised Variables

Find the value of x given information about the mean

The mean of $7, 3, 4, 8$ and x is 5, find the value of x.

$x =$ ____

Show steps *(You will lose 1 mark.)*

Submit answer **Score: 0/1** Try another question like this one Reveal answers

Randomised Variables

Find the value of x given information about the mean

The mean of $9, 6, 8, 8$ and x is 7.4, find the value of x.

$x =$ ____

Show steps *(You will lose 1 mark.)*

Submit answer **Score: 0/1** Try another question like this one Reveal answers

Randomised Variables

The selling price of a scarf is 9.30 euro.

This price was 55% greater than the cost to produce the scarf.

How much did it cost to produce the scarf and what was the profit?

Cost to produce: _____ euro

Profit: _____ euro

Submit answer **Score: 0/1** Try another question like this one Reveal answers

Randomised Variables

The selling price of a box of chocolates is 13.75 euro.

This price was 25% greater than the cost to produce the box.

How much did it cost to produce the box and what was the profit?

Cost to produce: _____ euro

Profit: _____ euro

Submit answer **Score: 0/1** Try another question like this one Reveal answers

Numbas documents on randomising variables: https://docs.numbas.org.uk/en/latest/question/reference.html?highlight=randomise#variables

Numbas Questions

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- ❑ Customised feedback

Fully Worked Solutions

Question progress: ***Solve for*** x

Solve for x in the following equation, giving your answer to 3 decimal places:

$$4e^{-4.9x} = 9$$

$x =$ _____ *Round your answer to 3 decimal places.*

Submit part

Or, you could:

Hint 1 - how to start

Hint 2 - a little more help

Hint 3 - finishing the question

Solve for x	0/2
Total	0/2

Try another question like this one

Reveal answers

Fully Worked Solutions

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Numbas documents on providing worked solutions: https://docs.numbas.org.uk/en/latest/question/reference.html?highlight=full%20solution#advice

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Sequential Hints

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Reveal answers

SPIRIT Maths

Sequential Hints

Question progress: Solve for x > ***Hint 1 - how to start***

Solve for x in the following equation, giving your answer to 3 decimal places:

$$4e^{-4.9x} = 9$$

Beginning with the given equation:

$$4e^{-4.9x} = 9,$$

we first divide both sides by 4 - the number in front of the exponential term - so that the exponential term will then be on its own:

$$\frac{4e^{-4.9x}}{4} = \frac{9}{4} \quad \{\text{Divide both sides by } 4\}$$

DIVISION by 4 cancels MULTIPLICATION by 4

$$e^{-4.9x} = \frac{9}{4}$$

Can you now use the key point from the worked example video to continue on with the question? To continue the question by yourself, click "Go back to the previous part" below or click "Solve for x" in the question progress bar at the top of the question. Otherwise, if you need some more help, click "Hint 2 - a little more help" below for a further hint.

What do you want to do next?

Go back to the previous part

Hint 2 - a little more help

Hint 3 - finishing the question

Solve for x	0/2
Total	0/2

Try another question like this one

Reveal answers

Sequential Hints

Question progress: Solve for x → Hint 1 - how to start → ***Hint 2 - a little more help***

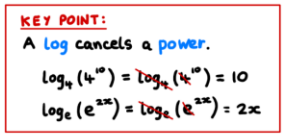
Solve for x in the following equation, giving your answer to 3 decimal places:

$$4e^{-4.9x} = 9$$

Our equation is now a little simpler than before. Since we now have

$$e^{-4.9x} = \frac{9}{4},$$

we can use the key point from the worked example video to help us get rid of the base e on the left-hand side:



That is, we can take $\log_e$ of both sides to get rid of the base e on the left-hand side:

$$\log_e\left(e^{-4.9x}\right) = \log_e\left(\frac{9}{4}\right) \qquad \{\text{Take } \log_e \text{ of both sides.}\}$$

LOG base e cancels POWER base e

$$-4.9x = \log_e\left(\frac{9}{4}\right)$$

Can you now find the value of x? To continue with the question yourself, click "Solve for x" in the question progress bar at the top of the question. Otherwise, if you need more help, click "Hint 3 - finishing the question" below for help with the final steps.

What do you want to do next?

Hint 1 - how to start

Hint 3 - finishing the question

Solve for x	0/2
Total	0/2

Sequential Hints

Question progress: Solve for x → Hint 1 - how to start → Hint 2 - a little more help → ***Hint 3 - finishing the question***

Solve for x in the following equation, giving your answer to 3 decimal places:

$$4e^{-4.9x} = 9$$

Now our equation is

$$-4.9x = \log_e\left(\frac{9}{4}\right)$$

To get x on its own, we must get rid of the -4.9 that is being **MULTIPLIED** by x. We therefore **DIVIDE BOTH SIDES** by -4.9:

$$\frac{-4.9x}{-4.9} = \frac{\log_e\left(\frac{9}{4}\right)}{-4.9} \quad \{\text{Divide both sides by } -4.9\}$$

DIVISION by -4.9 **cancels** **MULTIPLICATION by** -4.9

$$x = \frac{\log_e\left(\frac{9}{4}\right)}{-4.9}$$

Calculator work

$$x = -0.1654959625$$

$$x = -0.165 \quad \{\text{Round to } 3 \text{ decimal places}\}$$

Want some more practice? Click the "Try another question like this one" button at the end of the question.

What do you want to do next?

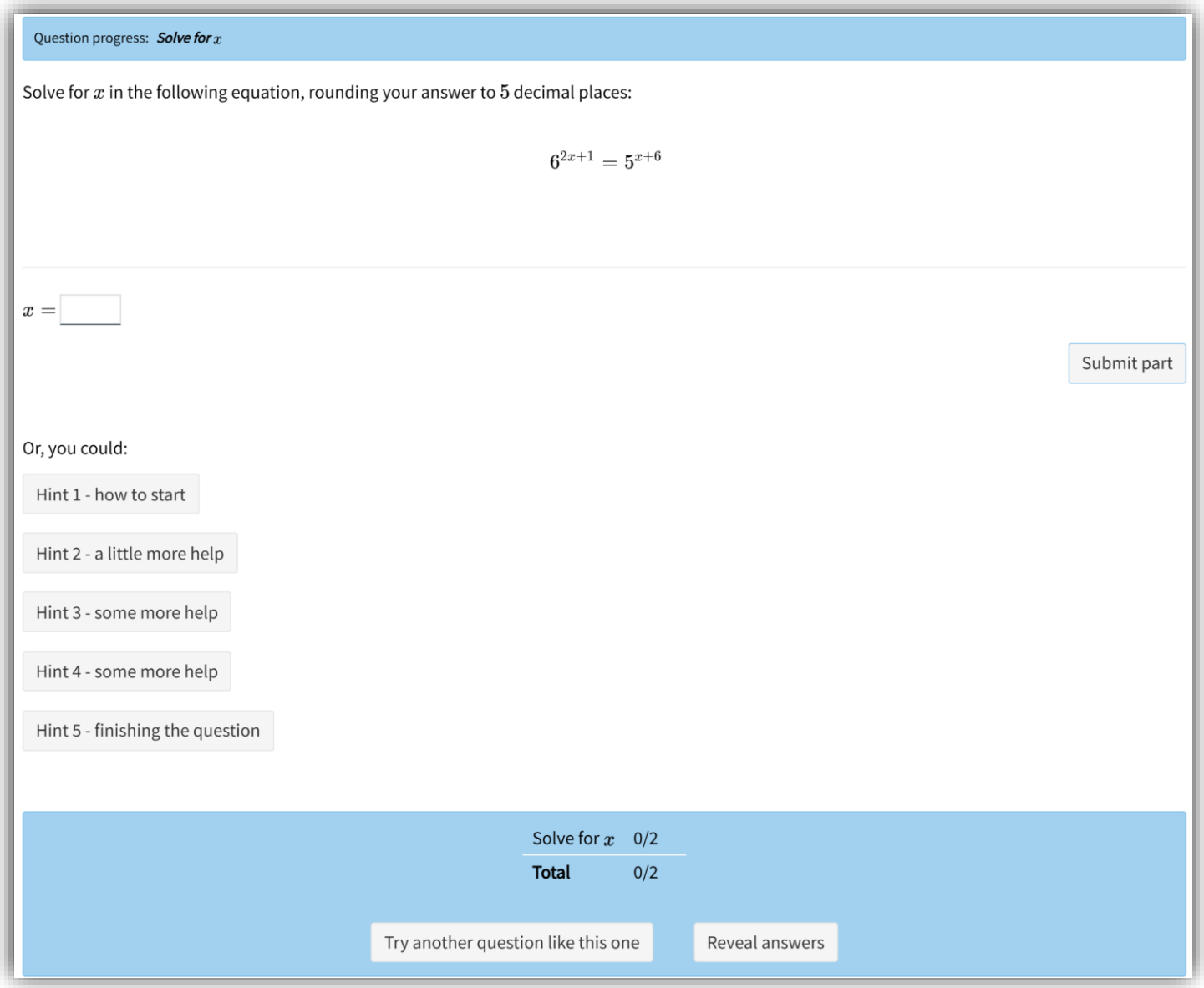
↶ Go back to the previous part

Solve for x	0/2
Total	0/2

Try another question like this one | Reveal answers

SPIRIT Maths

Sequential Hints



Numbas documents on providing hints: https://docs.numbas.org.uk/en/latest/question/explore.html

Numbas Questions

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- ❑ Customised feedback

Customised Feedback

The compound interest formula is:

$$A = P(1+i)^n$$

A business woman has borrowed money at a nominal rate of 4% interest compounded quarterly. If she owes €3248.57 after 2 years:

a)

What is the value of i?

Please give your answer correct to 5 decimal places.

Answer: 0.04 ✖

Submit part

✖ You have entered the nominal annual interest rate. This is incorrect because the interest is compounded quarterly (i.e. 4 times a year). For this example, the i in the compound interest formula represents the quarterly interest rate, which is the nominal annual interest rate divided by 4. It is important to remember that the interest rate must match the compounding period.

You scored **0** marks for this part.

Score: 0/1 ✖

Answered

Customised Feedback

Question progress: ***Find*** $f'(x)$

Let $f(x) = x^9 \cos(x)$ Find the derivative $f'(x)$.

Important Notes:

- **To enter $\sin(x)$ or $\cos(x)$, make sure you include brackets around the x.**
- **Make sure you use a multipliciation sign, *, between non-constant terms that are multiplied e.g., to enter $x^3 \sin(x)$, type x^3*sin(x).**

$f'(x) =$ `-9x^8*sin(x)` $-9x^8 \sin(x)$ ✖

Submit part

Take a closer look at the function you are differentiating. It consists of one function of x (i.e., x^9) multiplied by another function of x (i.e., $\cos x$). Therefore you need the product rule to differentiate.

Have you looked at the hints provided below? Don't forget you can always go back and have another look at the worked example video to see the method again.

You scored **0** marks for this part.

Score: 0/2 ✖

Answered

What do you want to do next?

Hint 1 - getting started

Hint 2 - finishing the question

Find $f'(x)$	0/2 ✖
Total	0/2 ✖

Try another question like this one

Reveal answers

SPIRIT Maths

Customised Feedback

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$f'(x) =$ `x^9*sin(x)+9x^8*cos(x)` $x^9 \sin(x) + 9x^8 \cos(x)$ ✔

Submit part

✔ Some good work done, but not quite there. Be careful when differentiating $\cos x$ - remember that $\frac{d}{dx}(\cos x) = -\sin x$ rather than $+\sin x$. You were awarded **1** mark.

Have you looked at the hints provided below? Don't forget you can always go back and have another look at the worked example video to see the method again.

You scored **1** mark for this part.

Score: 1/2 ✔

Answered

What do you want to do next?

Hint 1 - getting started

Hint 2 - finishing the question

Find $f'(x)$	1/2	✔
Total	1/2	✔

Try another question like this one

Reveal answers

Customised Feedback

Question progress: ***Solve for*** x

Solve for x in the following equation, rounding your answer to 2 decimal place(s):

$$\log_2(3x+4) - \log_2(2x-3) = 4$$

See if you can start the question by yourself first. If you need a hint, click on "Hint 1 - how to start" below.

Don't forget to round your answer to 2 decimal place(s).

$x =$ 1.63 ✖

Submit part

✖ Not there yet. Have you looked at the hints provided below? Don't forget you can always go back and have another look at the worked example video to see the method again.

You scored **0** marks for this part.

Score: 0/2 ✖

Answered

What do you want to do next?

Hint 1 - how to start

Hint 2 - a little more help

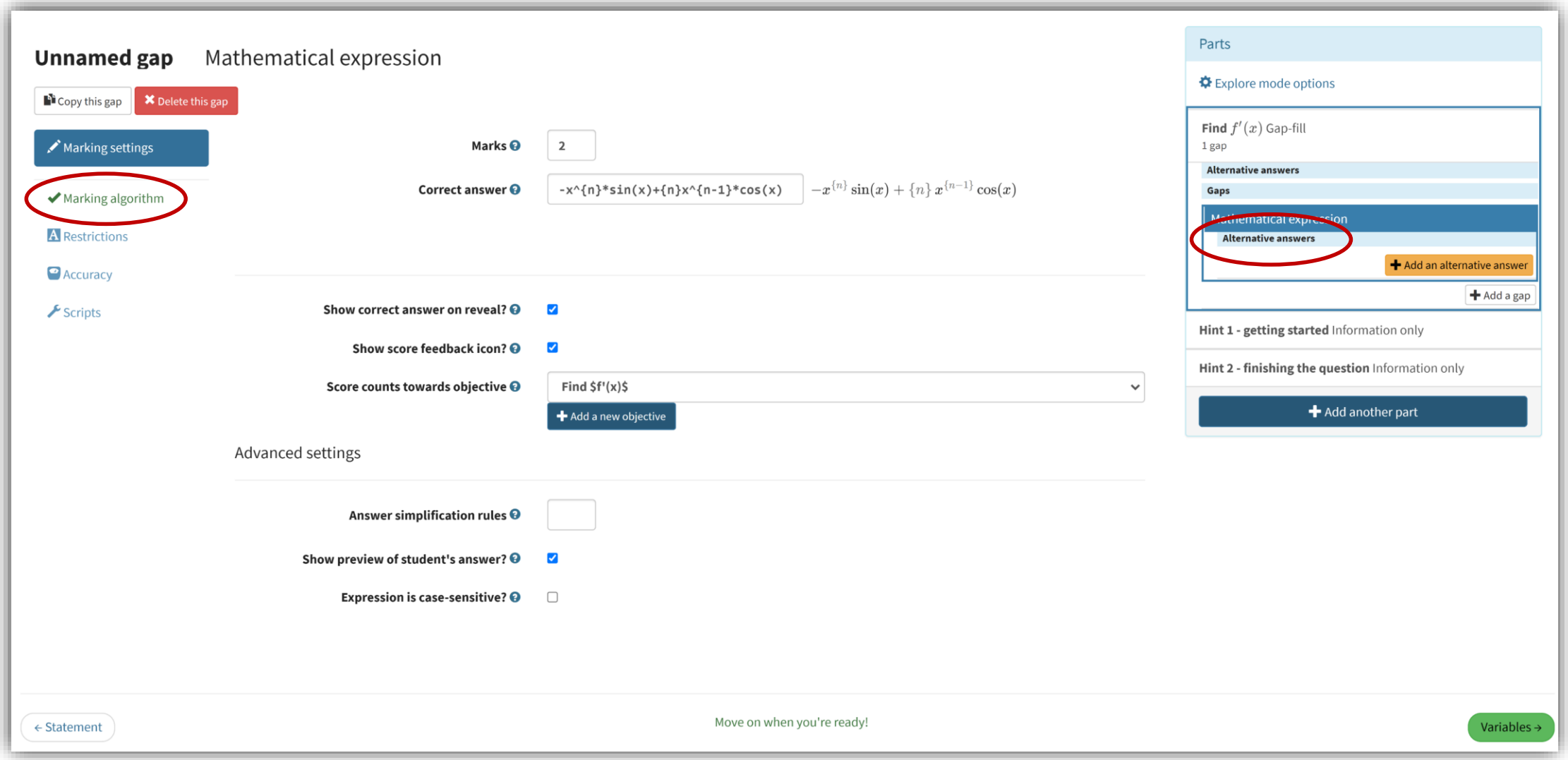
Hint 3 - finishing the question

Solve for x	0/2 ✖
Total	0/2 ✖

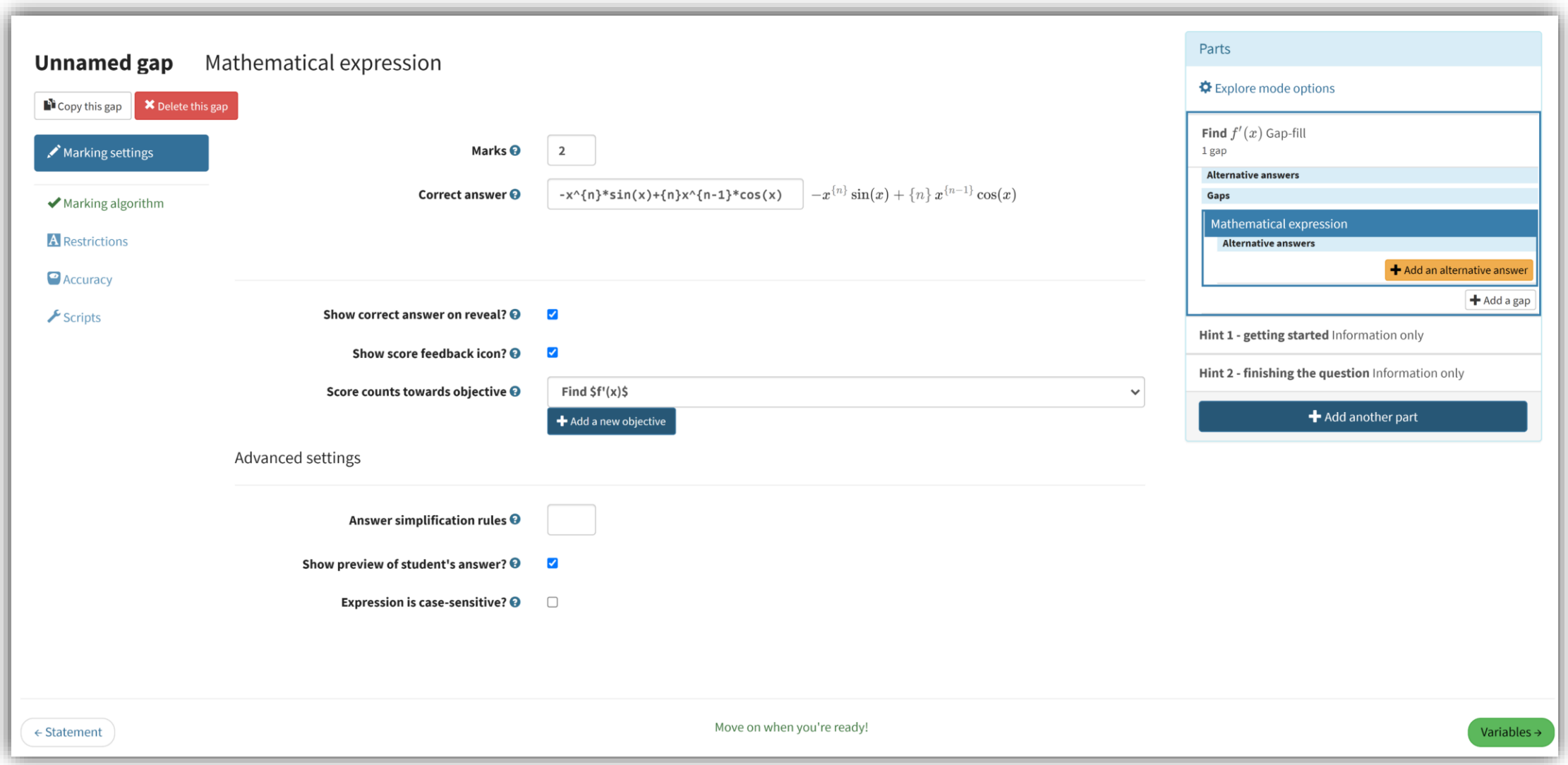
Try another question like this one

Reveal answers

Customised Feedback



Customised Feedback



Numbas documents on providing customised feedback using the “Alternative Answers” option: https://www.numbas.org.uk/behind-the-design/alternative-answers.html

Dissemination, Feedback and Impact

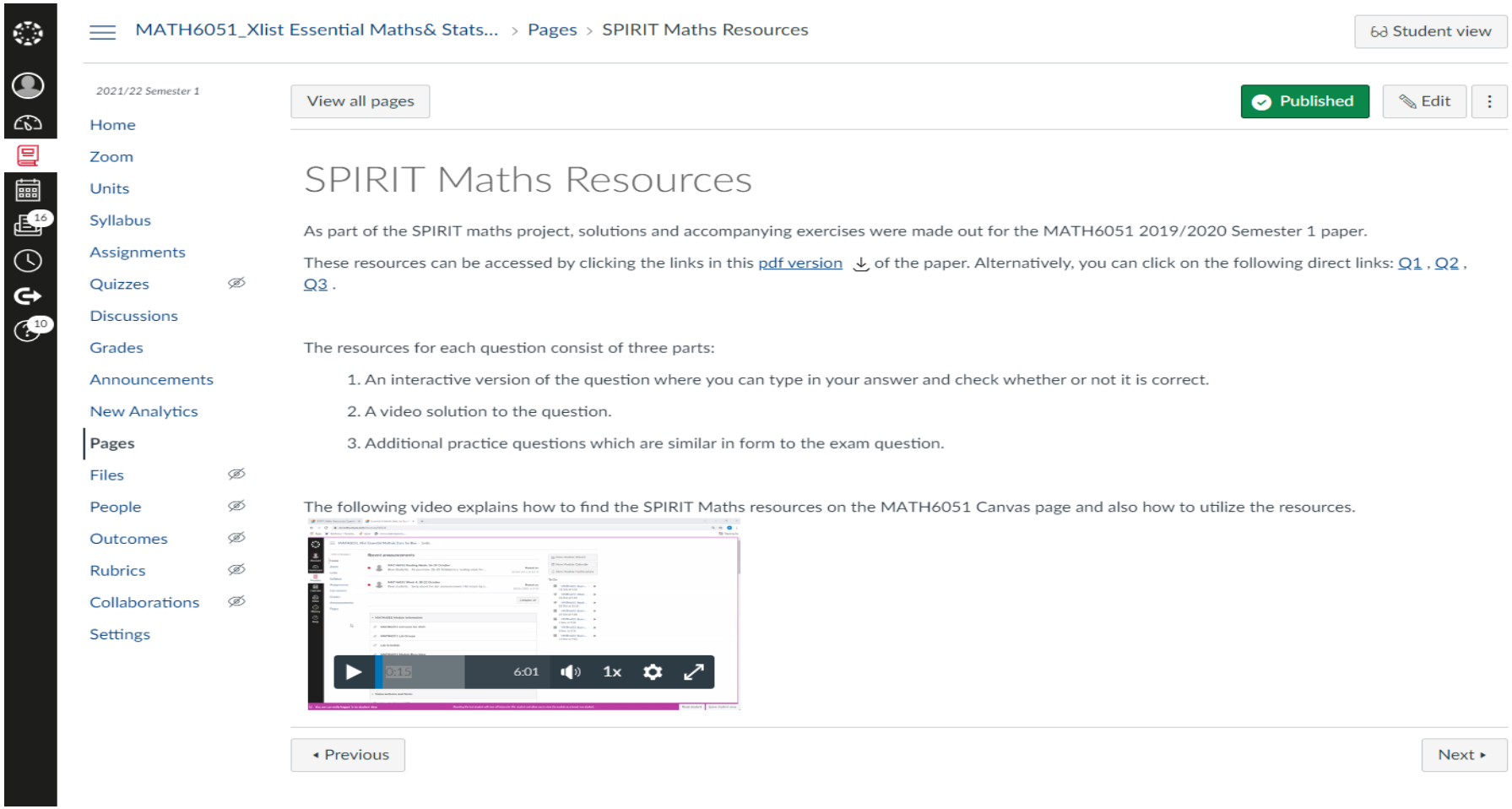
- Dissemination
  - How students access the resources
  - Publicising the resources

- Pilot study for initial feedback

- Impact
  - Engagement with the resources
  - Impact on student learning

Dissemination

- ❑ Canvas Learning Management Platform
- ❑ Resources accessible via Maths Online Module and individual modules
- ❑ All students taking a mathematics module at MTU are enrolled
- ❑ Landing page explaining how to use the resources (video)



- ❑ Canvas announcement with links sent out before reading week
- ❑ Lecturers gave an overview of the resources during class time

Pilot Study

- 5 volunteer students in semester 2 of 2020/2021 and a further 5 students over the summer
- Online survey and short follow up interview
- Positive aspects
  - Clear videos, able to rewatch and control pace of learning
  - Linking to similar practice questions in Numbas with instant feedback
  - Having the resources in the one place
- Negative aspects
  - Rounding issues in H5P and Numbas
  - One student did not see the Numbas questions

Measuring engagement with the resources

Teaching Mathematics and its Applications: An International Journal of the IMA (2020) **0**, 1–15
https://doi.org/10.1093/teamat/hrab016 Advance Access publication

Asynchronous online mathematics learning support: an exploration of interaction data to inform future provision

LINDA O'SULLIVAN[†], DEIRDRE CASEY[‡] AND JULIE CROWLEY[§,*]

Measuring engagement with the resources for MATH6051

- 226 students in total
- 71 (31.4%) students used SPIRIT Maths resources
- 48 (21.2%) students used SPIRIT Maths **Numbas** resources
- 42 (18.6%) students used SPIRIT Maths **video** resources
- 19 (8.4%) students used **both** SPIRIT Maths Numbas and video resources

Measuring impact of resources for MATH6051

- Response variable
  - Students final grade for MATH6051 (%)
  - proxy for mathematics understanding

- Explanatory variables
  - Students leaving certificate points
  - Video lectures views
  - Written notes views
  - Exercise sheets views
  - SPIRIT Maths Numbas grade
  - SPIRIT Maths videos views

Linear Model

Variable	Coefficient Estimate	Standard Error	t-value	P-value
Points	0.677	0.082	8.209	<0.001
Lecture Videos	0.067	0.025	2.664	0.008
Notes	0.060	0.085	0.705	0.482
Exercises	0.138	0.091	1.511	0.133
SPIRIT Numbas	0.021	0.01	2.107	0.037
SPIRIT Videos	-0.030	0.289	-0.102	0.917

Thank you!

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