Online calculus games for distance learners: what works and why

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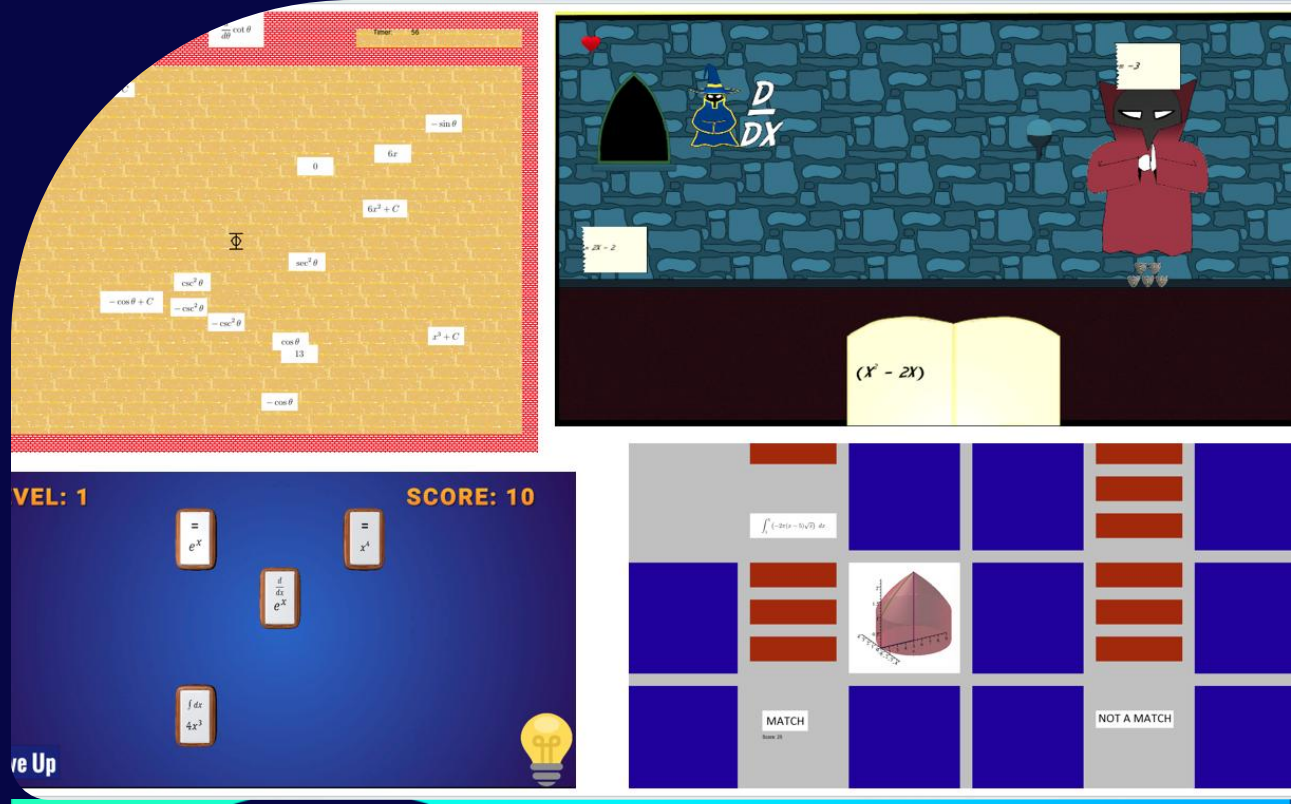

The problem

Distance calculus learning has three difficulties

- Students often practice alone.
- Feedback is not always immediate.
- Symbolic rules can feel abstract and repetitive.

Can digital games provide low-stakes practice, motivation and formative feedback for online calculus learners?

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The study

Distance learners often meet calculus alone: abstract symbols, limited immediate feedback, and uneven confidence.

Question

Can short didactic games support retrieval practice, motivation and revision in an asynchronous OU calculus setting?

Setting

MST125, MST224 and T272: foundational to intermediate calculus, mathematics and engineering learners.

Method

Three Unity WebGL games, voluntary survey feedback across three academic windows, plus open-text comments.

The aim is not to replace teaching materials, but to add low-stakes mathematical practice with feedback and learner control.

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Three calculus games: three learning mechanics

Maths-jong

Pattern matching for derivative rules. Low-pressure repetition supports fluency and visual memory.

Calculus Wizard

Symbolic choices embedded in light narrative and arcade feedback. Challenge rises by level.

Calculus Time

Timed problem application. Useful assessment-like pressure, but pacing must be adjustable.

Design principle emerging already: the mathematics must be intrinsic to the play, not just pasted onto the screen.

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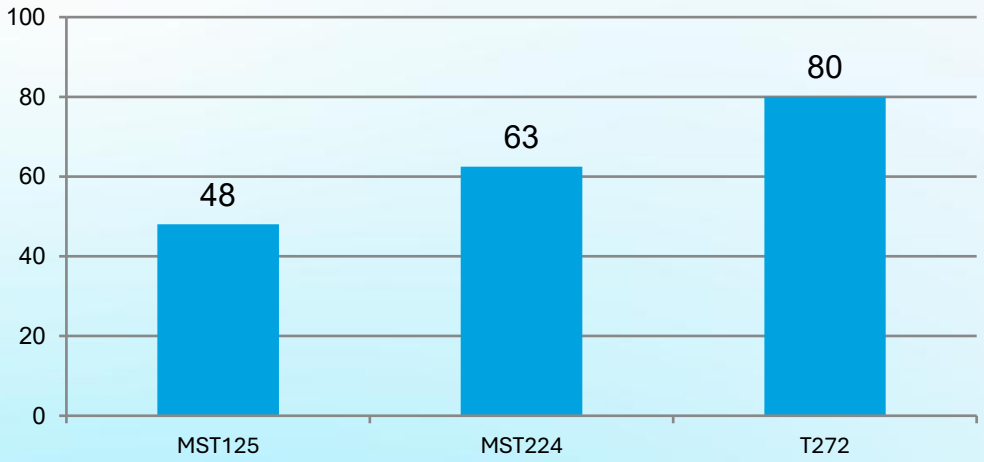
What students told us

91
complete survey responses
May 2024-May 2025

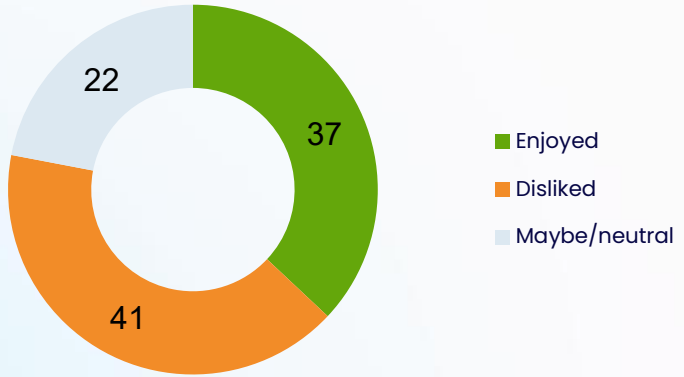
56%
positive about integration
all modules

>70%
Maths-jong favourite
strongest success

34%
used for revision
not yet embedded



Support increased from foundational maths to engineering contexts.



Timers energized some learners but created stress for others.

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From findings to design rules

Four rules for using games seriously in STEM teaching

1. Clear first move

Students need to know what to do within seconds. Instructions are part of the learning design.

2. Optional pressure

Timers can motivate, but should not be compulsory. Challenge and accessibility must be balanced.

3. Feedback loop

Hints, worked steps and correct-answer explanations convert play into formative learning.

4. Place in module

Games work best when signposted in revision weeks or linked to a tutorial/practice task.

Next step: dashboards and in-game micro-feedback, so tutors can see learning signals without turning games into high-stakes tests.

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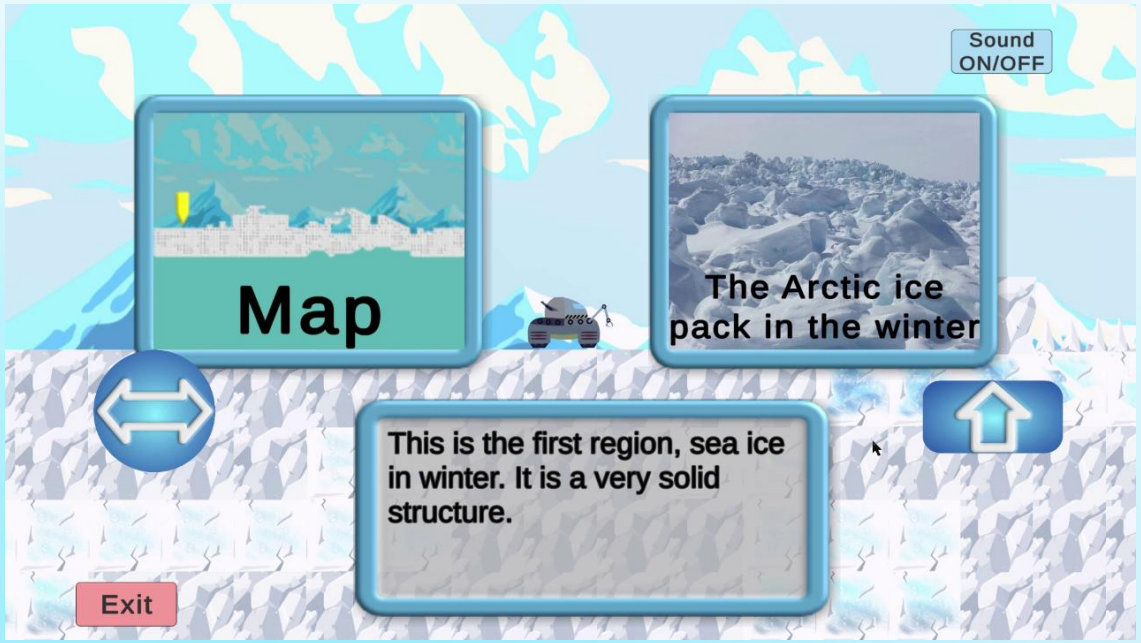
Beyond calculus: mathematics inside geoscience games



Outreach example 1: Global Worming

A geoscience/sustainability game showing how mathematical ideas can be embedded in an environmental scenario.

Outreach example 2: Arctic Adventures

Developed from research on a stochastic model coupling environmental change with complex phytoplankton community behaviour, including bloom development.

Transfer principle

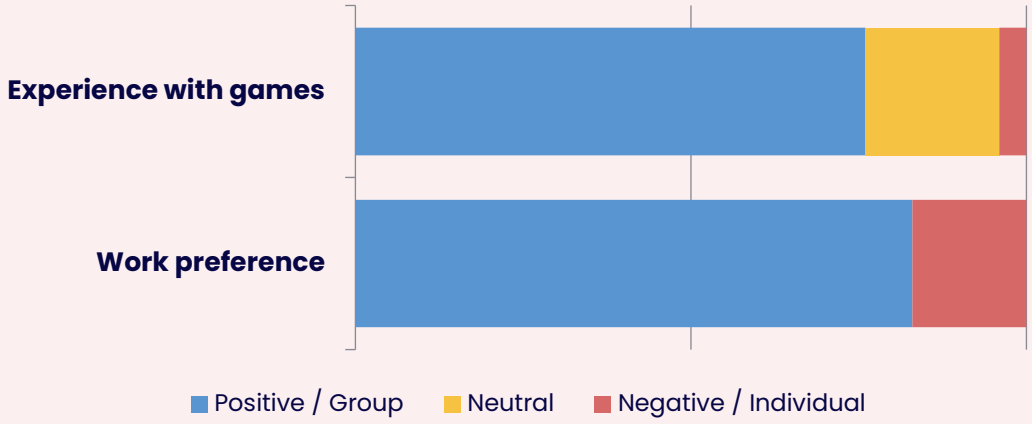
Do not start with formulas. Start with decisions, feedback and consequences - then reveal the mathematics underneath.

In-class vs online didactic games in calculus

In-class games

Setting: face-to-face classroom play, 2014–2015
Format: mostly group-based activities
In-class games ranked: Cards; Crossword (words); Puzzler; Four Letter Word; Auction (expressions); Crossword (problems); Auction (graphics)
Top-ranked: crossword games ranked 1st out of 7

Response patterns



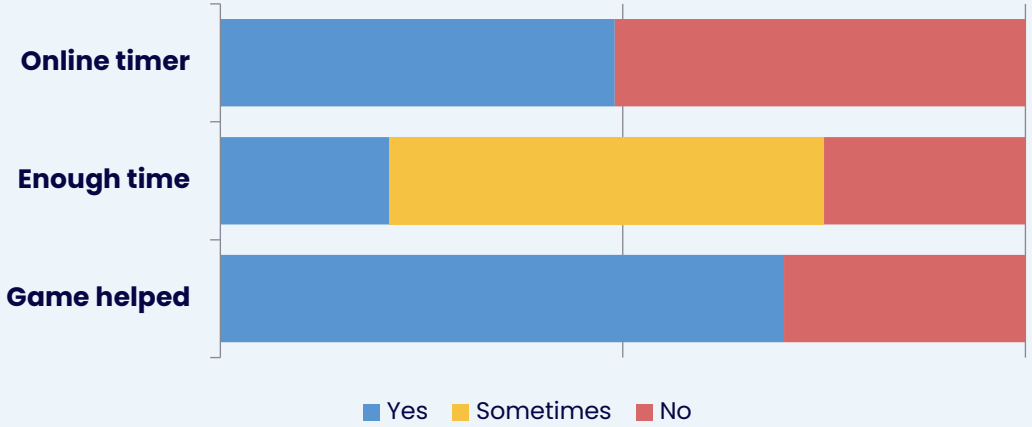
Additional in-class statistics

59.6% reported difficulty learning from lecture alone.
40.4% saw a gap between lecture and practice.
39.2% wanted more in-class illustrative examples.

Online games

Setting: browser-based individual play, 2015
3 online games: shooting (derivatives/integrals) + 2 matching games
Game ranking: shooting game 1st, implicit differentiation 2nd, volumes 3rd

Response patterns



Interpretation

Online games were generally helpful (70% yes).
Timing was the main tension: only 21% said there was enough time, and opinion on the timer split almost evenly.
Entertainment came largely from novelty and interaction.

Interactive activity: test the principles

1. Play the full pathway

Calculus practice: Maths-jong | Calculus Wizard | Calculus Time | Calculus Blaster |Matching Games
Outreach: Global Worming | Arctic Adventures

2. Notice the learning evidence

What do learners practise? What feedback do they receive? Does the game build confidence, curiosity, fluency or revision habits?

3. Exit-ticket assessment prompt

Complete two sentences:
“This game helped me learn because …”
“The next improvement should be …”

4. OU-wide discussion point

Where could gamification add value across OU modules: revision, tutorials, outreach, formative assessment or student co-design?

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Thank you