Integrating Worlds: An a priori Analysis of Contextualised NUMBAS Questions in Natural Sciences

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BACKGROUND

- In England, diverse entry pathways to university degrees result in varied student mathematical backgrounds (Hodgen et al., 2018).
- Students are expected to develop mathematical and data analysis knowledge and skills "sufficient to support subject understanding and problem solving" (Society for Natural Sciences, 2021, p. 12).
- The Natural Sciences course at the University of Bath offers various pathways for students to choose from.
- Admission does not require A-level Mathematics or equivalent.
- Mathematics provision is aimed at ensuring equitable opportunities and support for all students, fostering their academic aspirations while mitigating disparities in workload and preparation.
- The learning of this diverse cohort is supported by using NUMBAS, a web-based system for creating dynamic assessment questions.

AIM & RESEARCH QUESTION

- Design contextualised NUMBAS questions to support students' mathematical learning in Natural Sciences.
- What are the anticipated benefits and limitations of using contextualised NUMBAS questions to identify and support Natural Sciences students' mathematical needs?

METHODS

- Interdisciplinary approach based on evidence that non-mathematics specialists could benefit from studying mathematics in context (e.g., Watters et al., 2022).

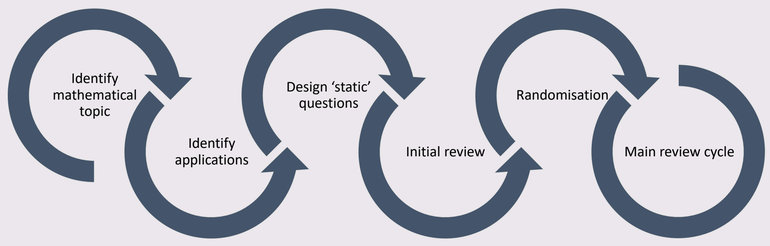

Figure 1: the initial design phase

- *An a priori* analysis of 20 contextualised NUMBAS questions.

Scan to interact with the question and **learn more**.

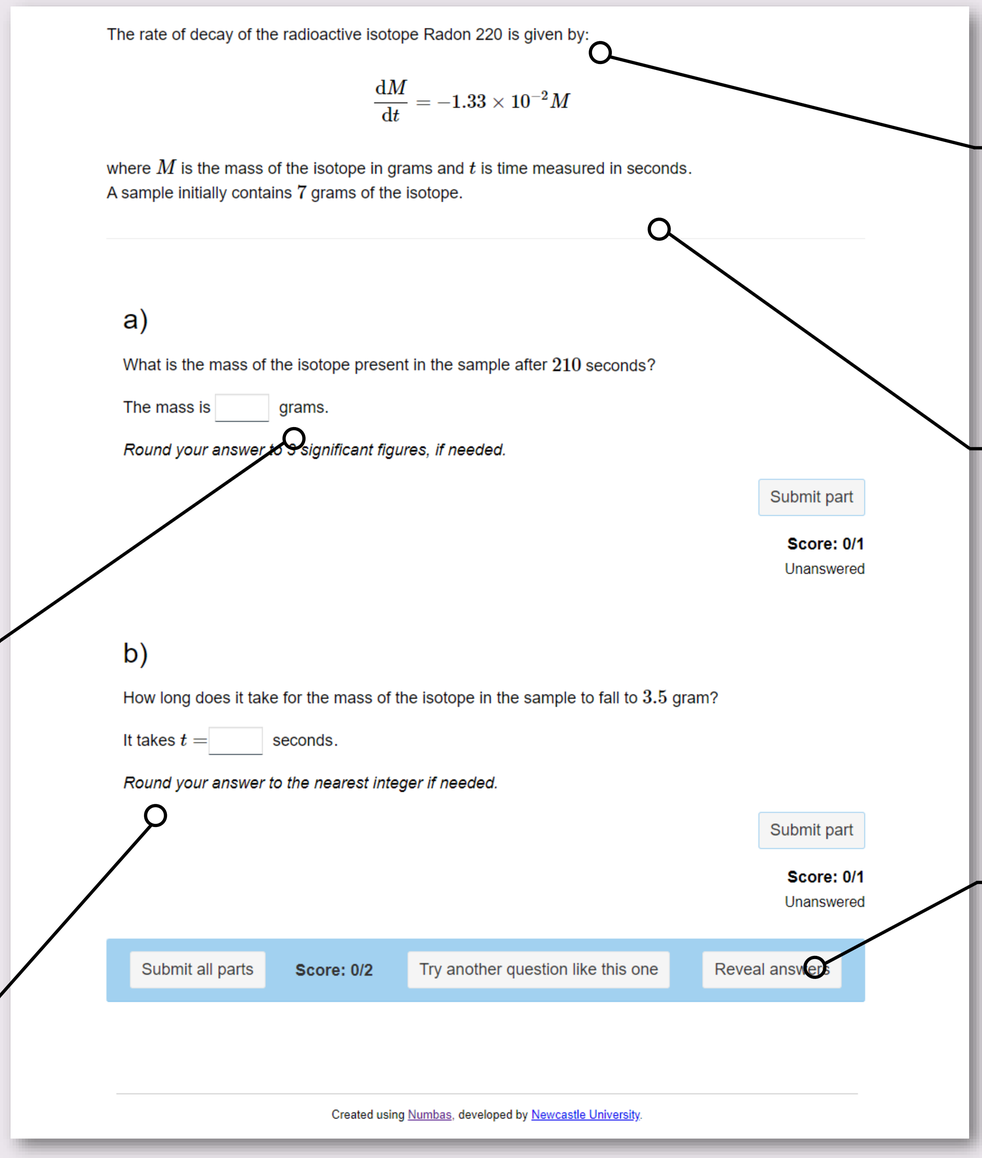

Figure 2: Screenshot of a NUMBAS question on radioactive decay

Working with quantities

+ NUMBAS supports the input and conversion of units
- specification of the units was not flexible

Rules for rounding

+ can be encoded at the design stage
- adjusting the tolerance can increase marking errors
- building a custom rounding algorithm can be time-consuming

Randomising the context

+ functionality to randomise both numbers and characters
- coding the context might lead to limited randomisation

Realistic and relevant examples

+ easy to design collaboratively
+ topics in line with A-level
+ topics required for 2nd year modules
- multiple rounds of review required

Advice

+ immediate feedback
+ introduction of language and notation
- no personalised feedback

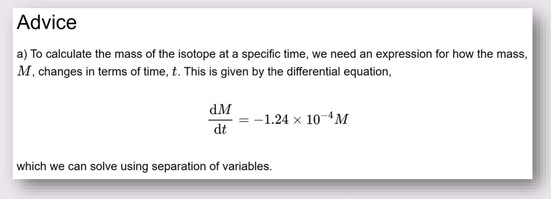

Figure 3: Part of the advice for the question

DISCUSSION

- The *a priori* analysis is the first step towards evaluating and improving the design.
- We anticipate that the design could:
  a. level the ground for students with diverse mathematical backgrounds,
  b. enrich their learning experience, and
  c. impact their future scientific endeavours that require mathematics.

FUTURE DIRECTIONS

- Collect and analyse data from student cohorts (e.g., usage and engagement, errors, scores).
- Improve the design through future design cycles.
- Adapt the design principles to be implemented in other disciplines.

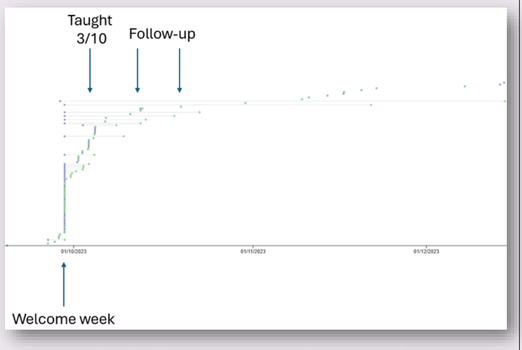

Figure 4: individuals' attempts mapped over time for NUMBAS quiz on quadratics

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