

FOSTERING CREATIVE MATHEMATICAL THINKING IN ELECTRONIC MATHEMATICS BOOKS (C-BOOKS)



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The MC-squared project

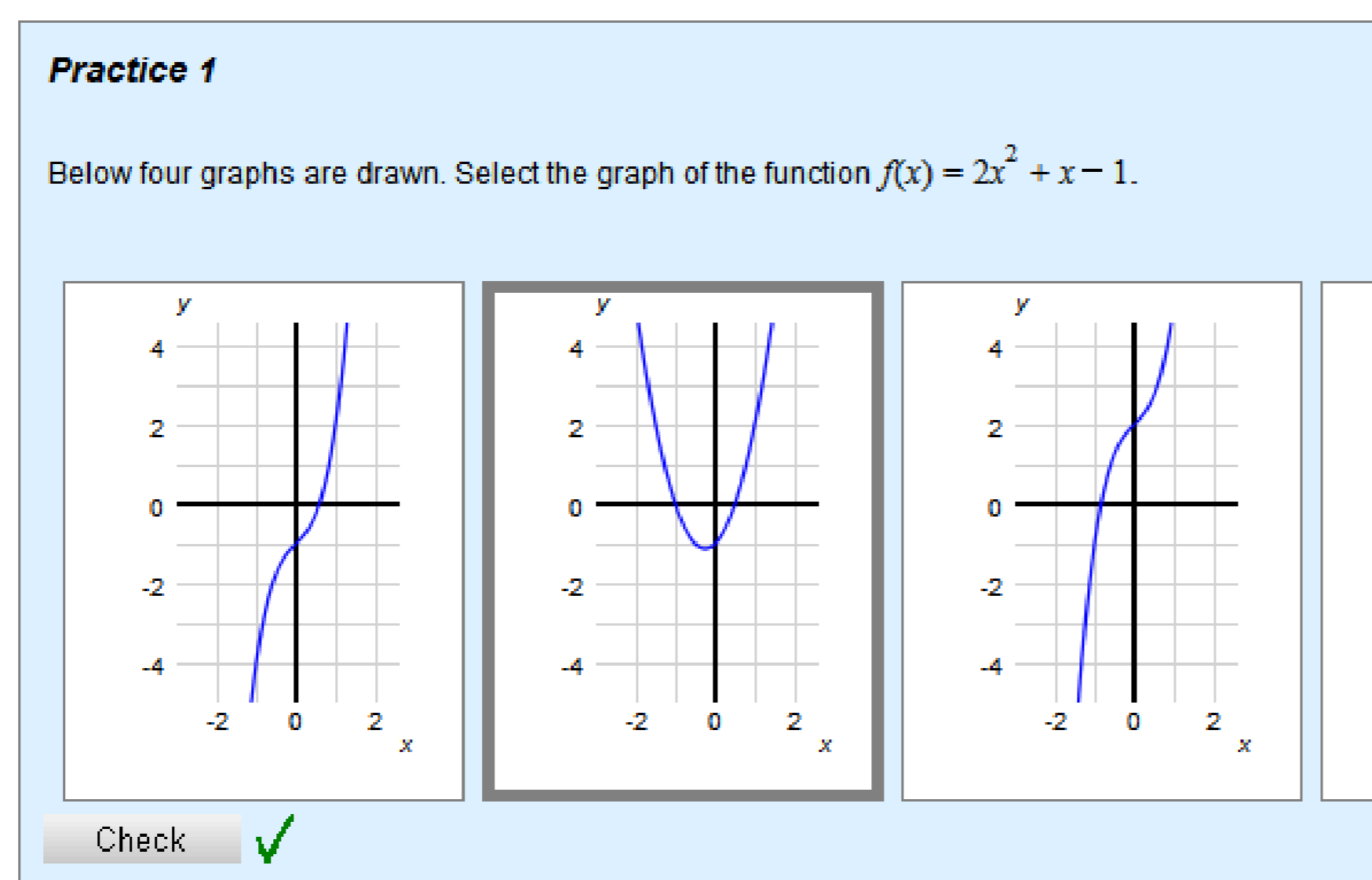
The MC squared project (<http://www.mc2-project.eu>) aims to design and develop a new genre of authorable e-book, which the project calls 'the c-book' (c for creative), extending e-book technologies to include diverse interactive components, learning analytics and collective design. As a research lens, literature from communities of interest (CoI) is used (Fischer, 2001). The project aims to harness the structure of a CoI to stimulate social creativity (SC) and creative mathematical thinking (CMT). In the UK CoI we are treating CMT in problem-posing and solving as entailing the indicators *fluency*, *flexibility*, *originality*, *elaboration*, and *usefulness* (Silver, 1997).

Evaluating CMT potential

In cycle 2 of the project, one of the research questions was: "how do five c-books authored by the CoI, demonstrate the elements of our CMT definition?" To address this question the CoI produced five c-books: one on transformations of graphs, one on planetary orbits, one on mathematics for biology, one on numbers and one on generalization. The c-books differed greatly in number of pages and number of interactive elements (widgets). After their conception, an evaluation instrument was used to evaluate the CMT potential. The instrument consisted of a template incorporating the creativity indicators mentioned above.

1. Transformations of graphs

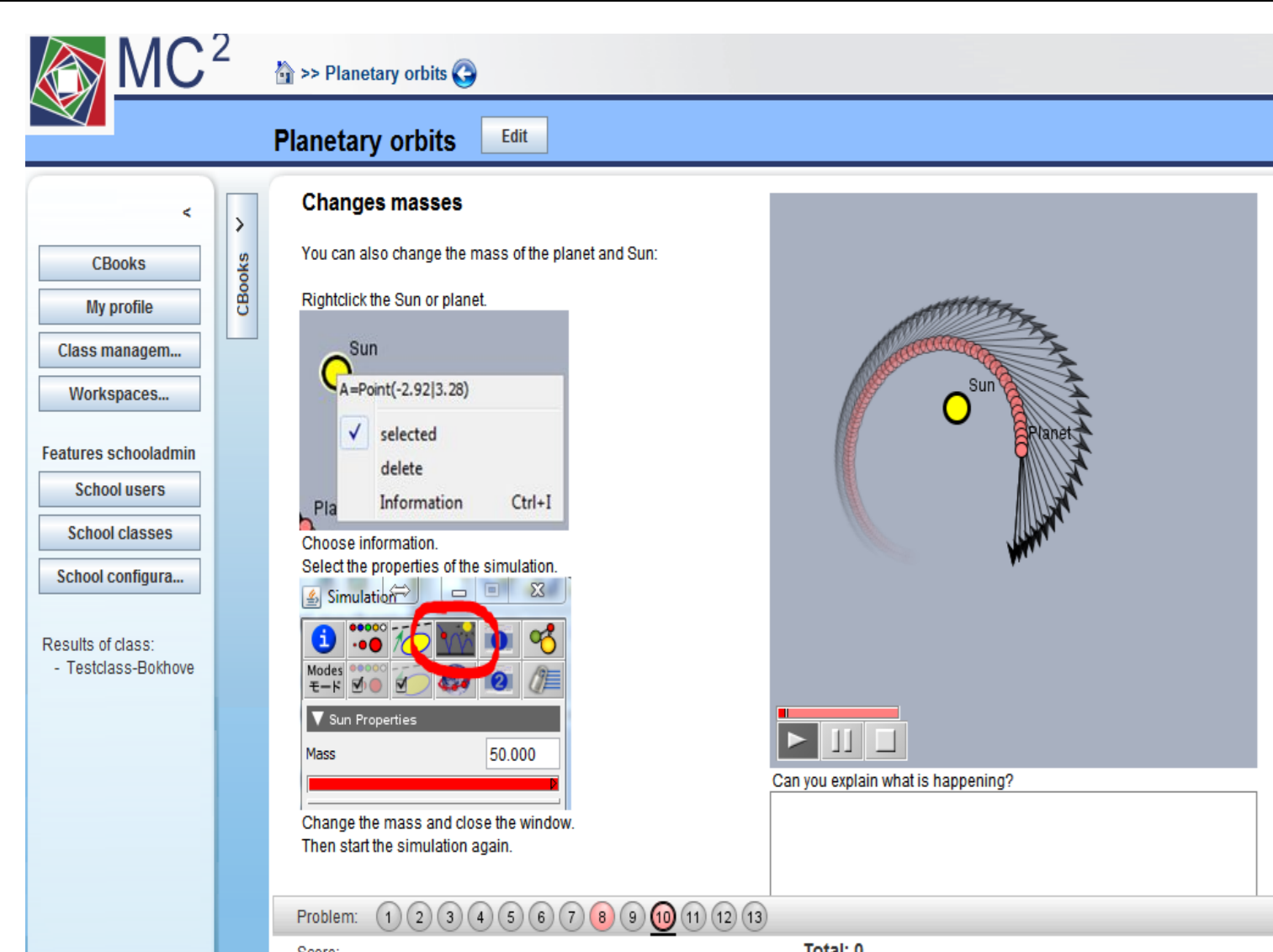
This c-book is about transformations of graphs of reciprocal, trigonometric and polynomial functions. The CMT potential of this c-book mainly seems to be the potential for *elaboration* as it primarily aims to describe, illuminate, and generalise ideas. However, one page, the last one of the third section has a more open approach, giving a moderate element of *flexibility* and *originality*. *Fluency* was not really apparent. The c-book's *usefulness* with its application in the UK curriculum is quite high.



Practice: not creative but useful

2. Planetary orbits

This c-book is about the gravitational laws concerned with planetary orbits. The CMT potential of this c-book mainly seems to be the potential for *fluency*, *flexibility* and *originality* in its open simulation approach in the second half of the c-book, and a moderate capacity for *elaboration*. The c-book is *multidisciplinary* in nature but does not necessarily address a *useful* topic from a curricular point of view.



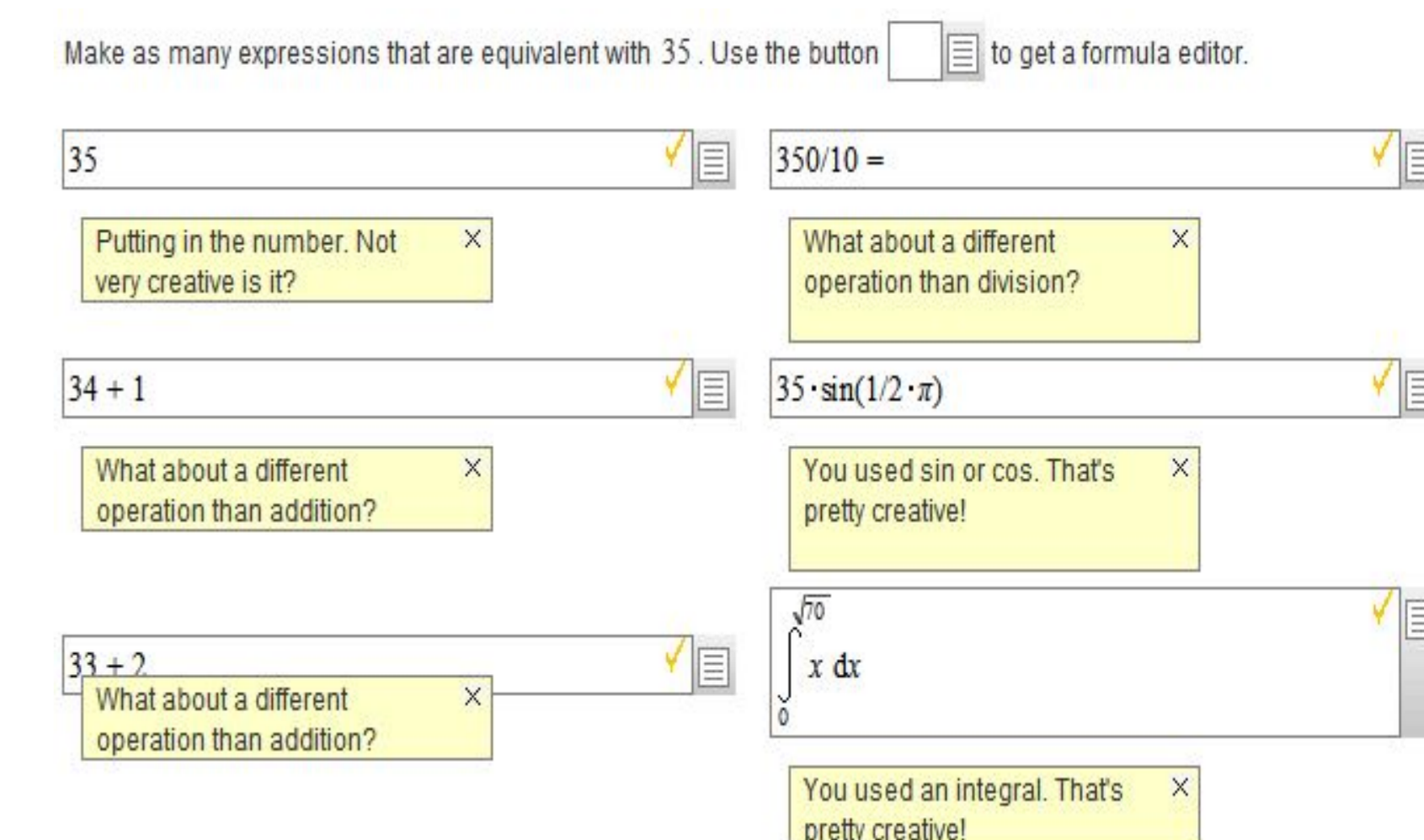
Simulating planetary orbits

3. Mathematics for Biology

This is a c-book with maths, mainly statistics, content which is in the new Biology A-level curriculum. The *fluency* aspect is not really apparent in this c-book. *Flexibility* and *originality* are mainly apparent in the more open tasks that are presented, with the final investigation probably the best example of this. The CMT potential of this c-book moderately concerns *elaboration* because of its application of knowledge and algorithms to new data. The c-book is *multidisciplinary* in nature and addresses a *useful* topic from a curricular point of view.

4. Numbers and expressions

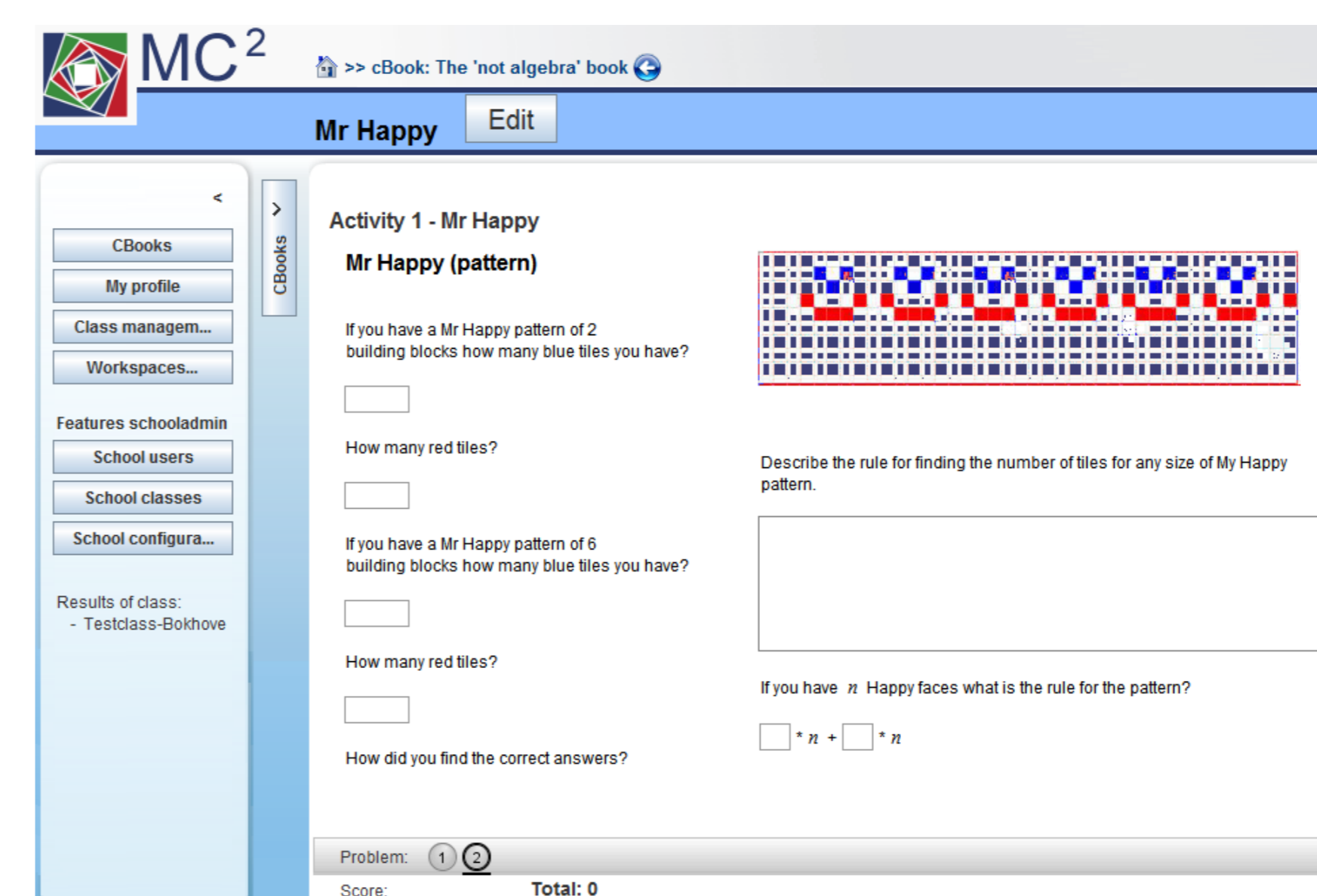
This icebreaker c-book asks students to rewrite numbers and expressions into equivalent numbers and expressions. The CMT potential of this c-book mainly seems to be the potential for *fluency*, *flexibility* and *originality/novelty* in students providing answers. This is only for a very limited content domain, which is convenient for the UK CoI's Learning Analytics goal. For this reason *elaboration* is not very prominent.



Attempts to provide feedback on creativity

5. Generalisation of patterns

This c-book features figural pattern activities encouraging algebraic ways of thinking. The CMT potential of this c-book mainly seems to emerge from the constructionist nature of the widgets involved and the potential for *fluency*, *flexibility* and *originality/novelty* in students providing answers.



Creating patterns with the eXpresser component

It pays particular attention to the UK curriculum, potential usage in the classroom and links with Learning Analytics. It tried to take the CoI c-book unit productions further in that the activities included the c-book are quite open-ended activities and can support students' exploration and experimentation.

Conclusion

The evaluation showed that most c-books had a mix of open and closed elements, sequenced in an intentional way to facilitate learning. Two out of five c-books (planets, and mathematics for biology) had a particular *multi-disciplinary* focus, while the other three stayed more in the realm of mathematics. It could be seen that the open or closed character of a c-book was mainly determined by the overarching learning objectives of the c-book. However, in all cases, the CoI still viewed them as *creative* products. In other words, *creativity* according to the CoI's definition is not a simple case of creating open or closed tasks but more a carefully-designed sequence of 'pages' and tasks that together potentially induce creativity.

References

Fischer, G. (2001). Communities of interest: learning through the interaction of multiple knowledge systems. In the *Proceedings of the 24th IRIS Conference* (pp. 1-14). August 2001, Ulvik, Department of Information Science, Bergen, Norway.
Silver, E. (1997). Fostering creativity through instruction rich in mathematical problem solving and problem posing. *ZDM: The International Journal on Mathematics Education*, 29(3), 75-80.