AUTHORING YOUR OWN CREATIVE, ELECTRONIC BOOK FOR MATHEMATICS: THE MC-SQUARED PROJECT

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The EU-funded 'MC-squared' project is working with a number of European communities to develop digital, interactive, creative, mathematics 'textbooks' that the project calls 'cBooks'. The cBooks are authored in a Digital Mathematics Environment in which participants can construct books with various interactive 'widgets'. This paper provides an outline of the MC-squared project illustrating an interactive storyboard of the Digital Mathematics Environment architecture. This includes examples of how authoring by cBook designers of interactive 'widgets' is possible. The workshop that relates to this paper is augmented, of course, by suitable 'hands-on' materials aimed at two possible cBooks: one focusing on aspects of geometric and spatial thinking using building blocks, the other on aspects of number and fractions.

Keywords: e-textbook, digital textbook, creative mathematical thinking, creativity

INTRODUCTION

The MC squared project (http://www.mc2-project.eu) aims to design and develop a new genre of authorable e-book, which we call 'the *cBook*' (c for creative), by extending e-book technologies to include:

- diverse interactive components [often called dynamic widget];
- interoperability [meaning that the *cBook* should work on any contemporary computer or tablet],
- collective design [including publishers, developers, researchers, school educators]
- contextual pedagogical cues to augment the learning activities

To develop the concepts and community knowledge for the design of authentic creative learning activities a collaborative design-based research methodology inspired by 'communities of practice' (Wenger, 1998) and 'communities of interest' (Fischer, 2001) is being used. For more background to this, see Bokhove, et al. (2014). Here we briefly outline some of the features of the DME, the environment used for authoring the first cBooks for the project. The workshop that relates to this paper is supplemented, of course, by suitable 'hands-on' materials.

DESCRIPTION OF THE C-BOOK ENVIRONMENT

A Digital Mathematical Environment (DME) provides the starting point for authoring *cBooks*. The functionality planned for the first version was:

- Text, graphics, and media files; these can be added using a WYSIWYG editor.
- Pre-made interactive 'widgets'; these can range from more closed multi-step equation boxes to very open tools for construction tasks.
- Storing student work.

Figure 1 is a storyboard of the *cBookAuthor* that the MC-squared team envisages to design classroom tasks (the snapshot in Figure 1 is based on the Digital Mathematics Environments, DME, of the Freudenthal Institute).

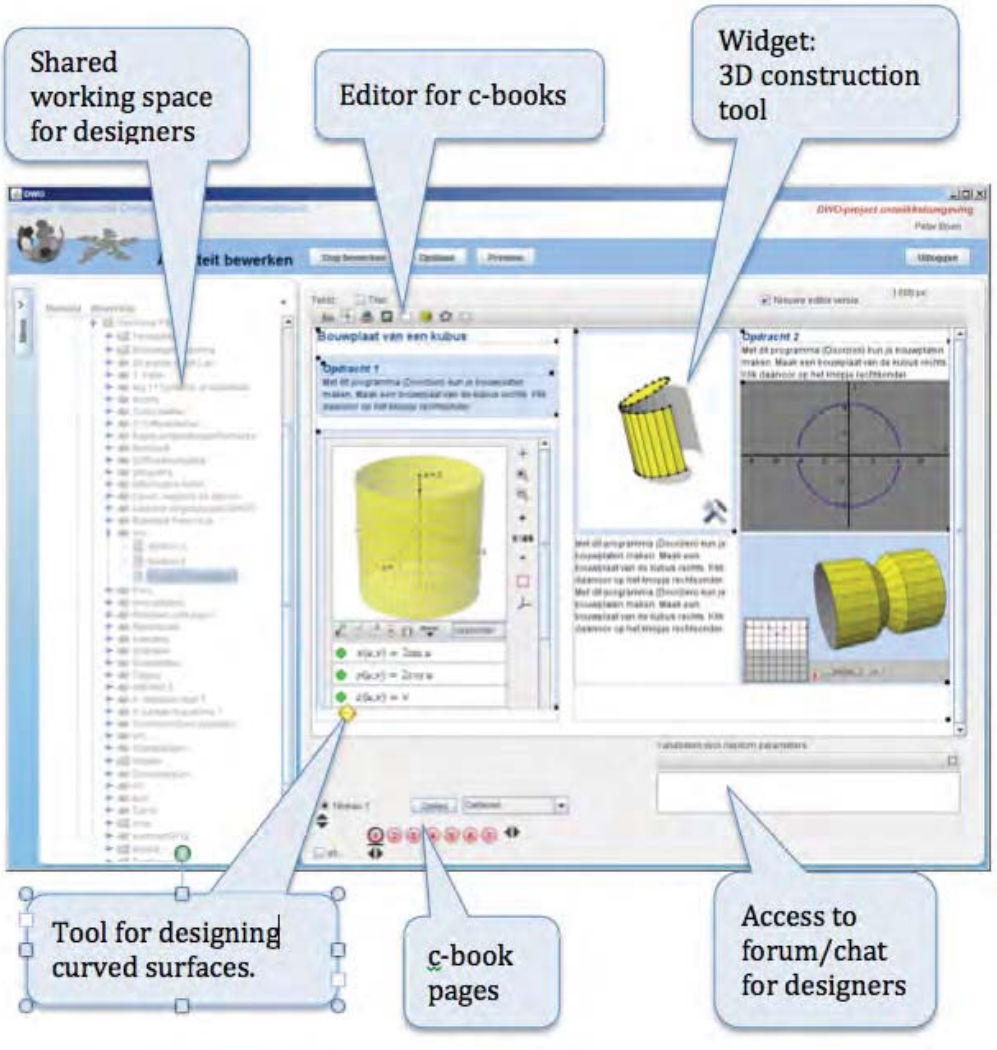


Figure 1: Storyboard of a future authoring a cBook

During the course of the project the features of the authoring environment are being extended to facilitate the creative design process of the *cBooks*. Each of the 'communities of interest' are providing feedback on their experience of using some of the DME features, which includes giving advice and guidance on authoring requirements. Future features are planned to include:

- More interactive widgets that can be integrated into a *cBook*.
- Chat and forum function for communication between community members regarding *cBooks* that are being designed, with a shared working place and a repository of earlier designed *cBooks* that can be (partly) re-used, adapted and discussed.
- Collection of appropriate data with respect to student usage, enabling provision of intelligent support in the form of feedback to learners, but also to designers within the authoring environment. Logging and mind-map features for facilitating the creative design process.
- Pedagogical cues set by the designers and/or tutors that provide learning analysis about the students' engagement with learning activities both for student learning development and teacher reflections.

In the first phase of the project, the aim has been to use the authoring environment 'as is' with only a small selection of widgets added to the ones that were already available in the DME. The remainder of this document provides some examples of the current features.

AUTHORING

cBooks are authored in a WYSIWYG environment, as depicted in Figure 2. The main editor allows authors to add and remove pages to a *cBook*, adjust their order, add different types of feedback and scoring, and - most importantly - add a variety of elements to these *cBook* pages, ranging from basic static texts to complex, interactive widgets.

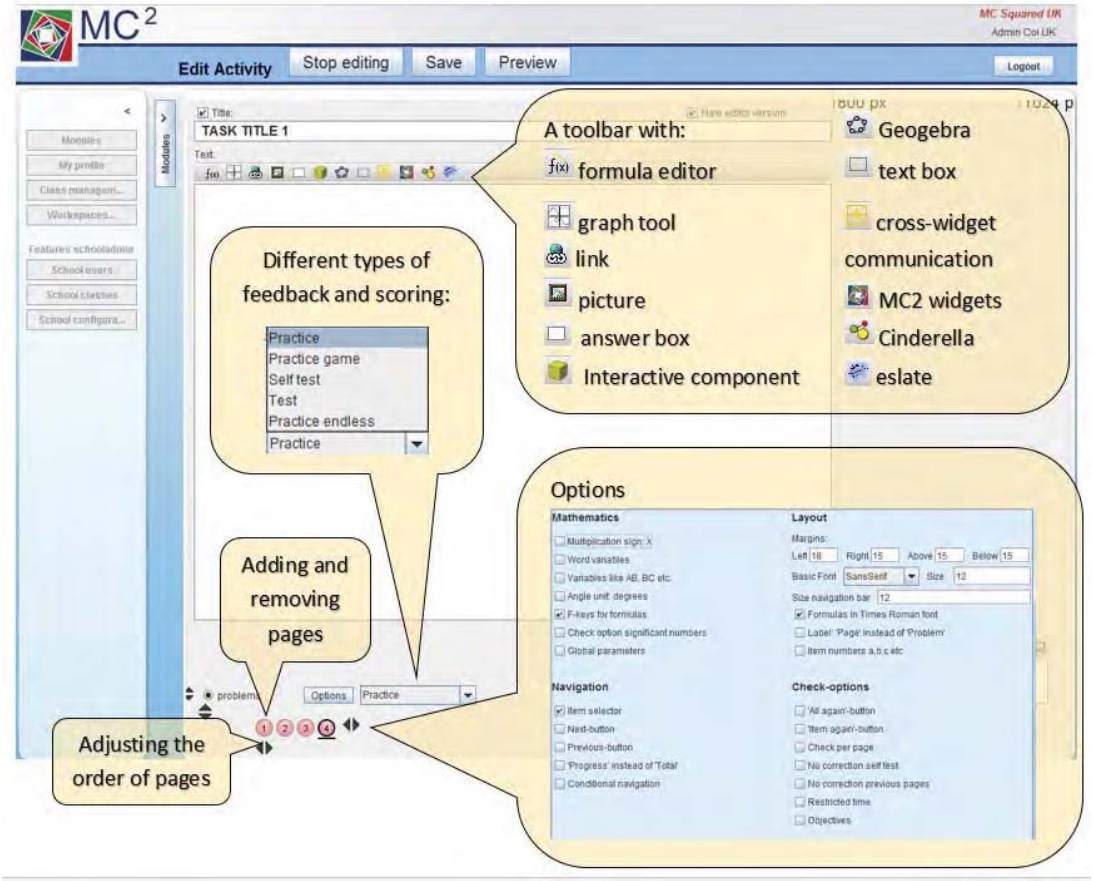
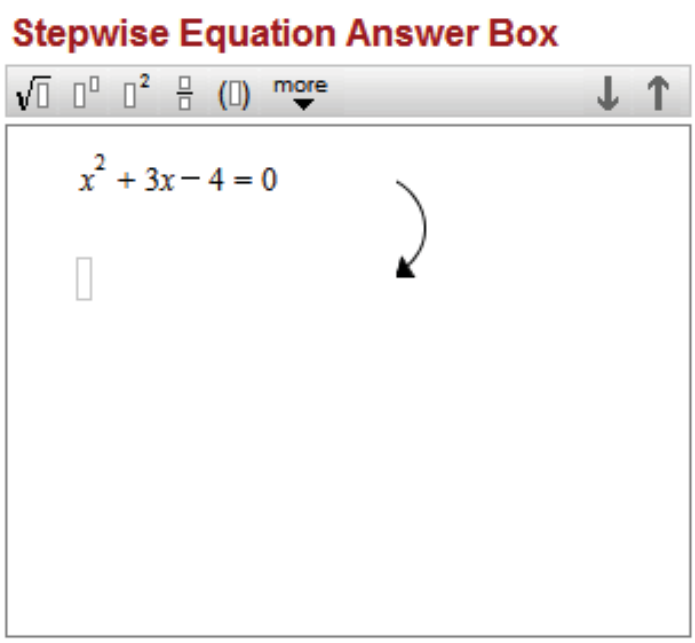


Figure 2: overview of the editing window (adapted from: Abels, Boon & Tacoma, 2013)

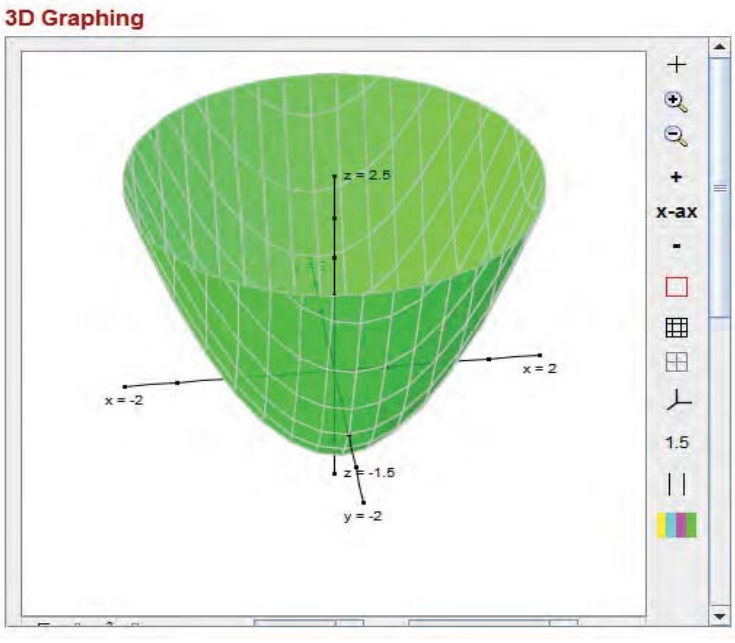
EXAMPLE WIDGETS

There are several widgets that can be used in authoring. They can be classified into basic widgets, algebra widgets, geometry widgets, statistics and probability widgets, and other widgets. To typify these categories we give an example for every category. One characteristic of the widgets is that they can be customized in such a way that they can be very open, exploratory tools or very closed (even serving as static diagrams).



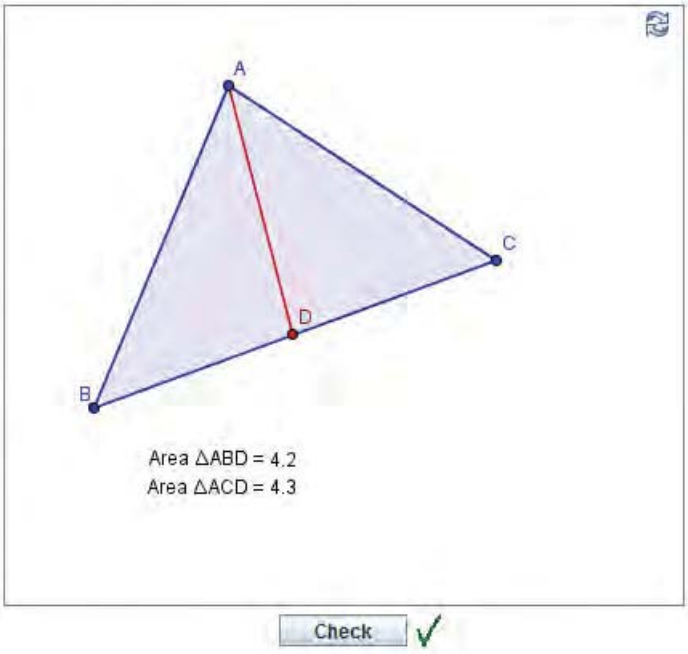
Basic

In a stepwise equation answer box, students can solve equations step by step. After each step they press Enter, to check whether the step is correct and to be able to move to the next line. A variety of options available: custom feedback, strategy functions, scoring, visual aspects and more.



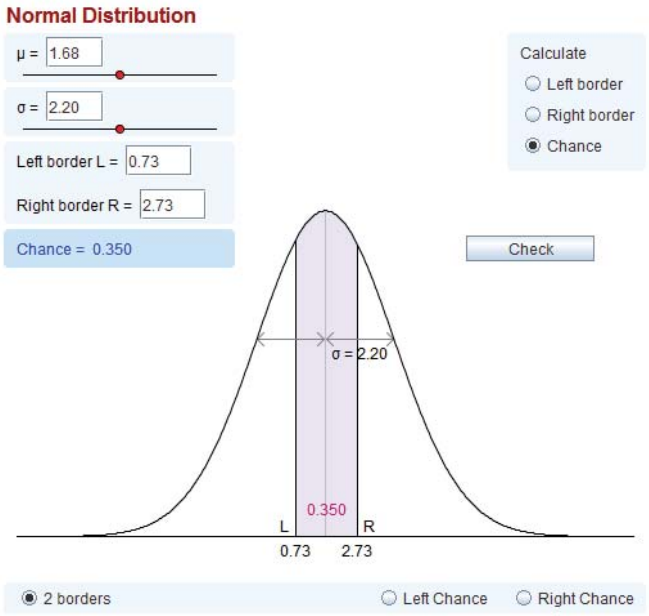
Algebra

With this tool, 3D graphs, surfaces and curves can be created, viewed and manipulated. The tool contains a collection of examples of graphs, surfaces and curves, which can be chosen as base for new figures. There are customizable options for graphing, what manipulations students are allowed to do, and example graphs that can be used.



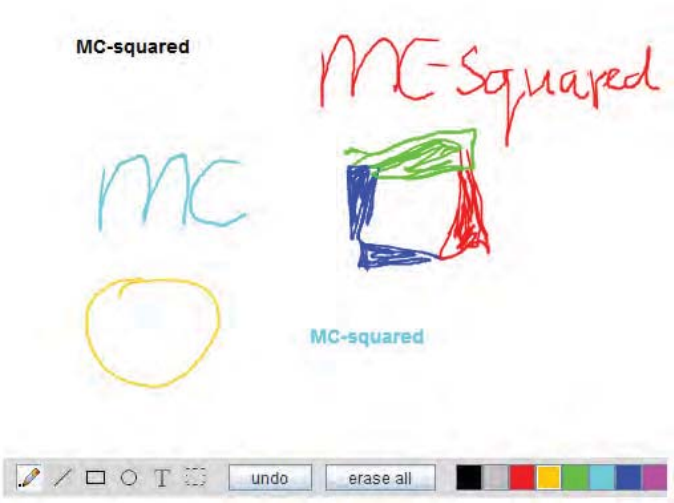
Geometry

Geogebra can be used for a wide variety of tasks, by providing an empty workspace or a pre-made construction. The task for the Geogebra instance to the right is: Move point D such that the area of the triangles ABD and ACD become the same (a difference of 0.1 is allowed). There are customizable options, for example, what Geogebra buttons are available to the students, and what elements are visible. In addition, constructions can be checked on correctness.



Statistics and probability

This statistical widget represents normal distributions and allows students to see how different values of the relevant variables change the distribution. There are customizable options for what elements are visible but also whether students can manipulate the distribution with sliders. In addition, check options are available.



Other widgets

This applet can be used by students to draw sketches, containing points, lines, rectangles, circles and text. It, for example, allows students to express

TO CONCLUDE

This paper provides an overview of some of the features of the (authoring) environment that is used by the 'Communities of Interest' in the MC-squared project. The tool is used to author creative *cBooks* with interactive features for mathematics education. The workshop that relates to this paper is augmented, of course, by suitable 'hands-on' materials aimed at two possible cBooks: one focusing on aspects of geometric and spatial thinking using building blocks, the other on aspects of number and fractions.

The first groups within the community of interest have been established. The next step is to develop new *cBooks* and improve the initial versions. This can only be done in close collaboration with different stakeholders: researchers, designers, and teachers. If you would like to join the community or participate in the project or require more information please contact the first author.

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