Collaborative Design of Educational Digital Resources for Promoting Creative Mathematical Thinking

Jana Trgalová[1], **Mohamed El-Demerdash**[1,2], Oliver Labs[3], Jean-François Nicaud[4]

[1]Claude Bernard University - Lyon 1 (France), [2]Menoufia University (Egypt), [3]Universities of Potsdam and Mainz (Germany), [4]Aristod (France)

Presentation Structure

1. The MC Squared Project

2. c-book unit Designers

3. c-book unit Content and Rational

4. c-book unit Design Choices

5. c-book unit Technology Added Value

6. Teacher's A priori Evaluation of the c-book unit

7. Conclusion

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The MC Squared Project

- This project aims at designing and developing an intelligent computational environment, called **C-book Technology**.

- The C-book technology provides an authorable dynamic environment extending e-book technologies to include diverse dynamic widgets, an authorable data analytics engine and a tool supporting asynchronous **collaborative design** of educational resources, called **c-book units**.

- The project focuses on studying processes of **collaborative design** of digital media intended to enhance **creative mathematical thinking**.
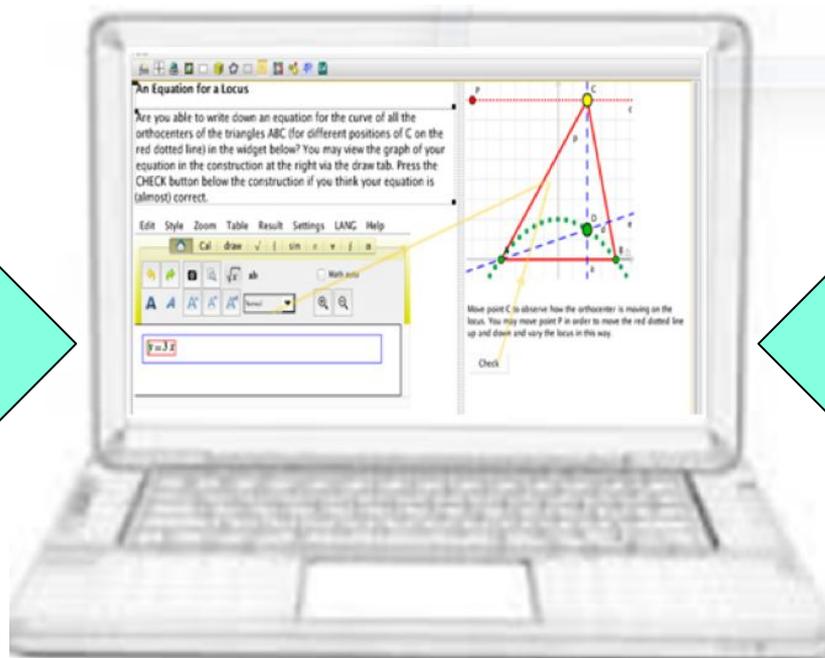
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c-book unit Designers

French CoI

- **Math edu researchers**

- **Teacher educators**

- **Computer science**

- **Software designers**

Other Partners

- **Math researchers**

- **Computer science researchers (LA)**

- **Software designers**

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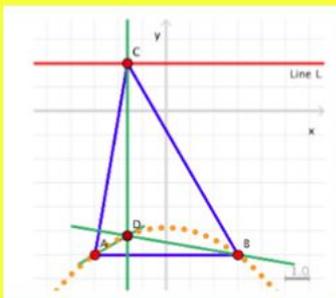7. Conclusion

c-book unit Content and Rationale

HISTORY
Locus of the orthocenter of a triangle is a well-known problem

EDUCATION
Concept of geometric locus of points difficult to grasp

A rich situation offering a possibility to generate a great variety of problems
CREATIVITY

Using c-book affordances to allow geometric and algebraic exploration
TECHNOLOGY

ICME 13
Hamburg 2016

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c-book unit Design Choices

- **Non-linear personalized path:** One main activity with possibilities to work out prerequisite knowledge in two additional activities reachable by hyperlinks.

- **Autonomous learning:** Rich exploratory environment constituted by dynamic geometry and dynamic algebra interoperable widgets; personalized feedback based on learning analytics.

- **Constructivist approach – learning by doing:** Problem solving activities in which students explore a given situation, make conjectures, verify and prove them.

c-book unit Design Choices (Continued)

- **Metacognition – learning by reflecting on own activity:** Students are invited to summarize what they have learnt.

- **Stimulating creative mathematical thinking:** Fostering CMT by inviting students to devise and explore their own activities from the initial one (elaboration) in many (fluency) different ways (flexibility) some of them being possibly original (originality).

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c-book unit Technology Added Value

- **Cross-widget Communication:** DG and DA widgets communication provide opportunities to make connections between different representations of a mathematical concept.

- **Design of adapted Widget Instances:** Students are offered tools that are needed to solve problems based on integrating different widget factories.

- **Adapted Feedback:** Based on a priori analysis of the mathematical problem and on LA, appropriate feedback, both technical and didactical, is provided.

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Teacher's a priori Evaluation of the unit

- A questionnaire was designed to gather the teachers' opinions about the c-book unit and its potential to foster CMT among users. This questionnaire has 2 main dimensions:
  - Gathering teachers' representations of creativity in mathematics.
  - Gathering their opinions about the c-book.

- We collect the teachers' responses via Google Form as a tool for gathering opinions.

- So far, we have received 4 responses and we expect others, the results we are going to show are based on these four responses.

Teacher's A priori Evaluation of the unit

The c-book makes first the students manipulate and observe which leads them to respond intuitively and then invites them to test their conjectures.

In my opinion, the fact that the c-book promotes the mode "Conjecture Validation" fosters creativity without generating fear of error for the student (especially as he is facing a computer rather than a teacher).

DGS promotes experimentation if the student is not able to conjecture … s/he will play with elements s/he chooses in order to observe the impact which will feed into new ideas and thus foster his/her creativity.

Teacher's A priori Evaluation of the unit

The student is obliged to test by writing an equation in the form of y=f(x) however s/he has many choices of algebraic tools that s/he can use in the expression f(x)
Finally the hints are welcomed they allow not to be discouraged and stimulate students who have no ideas to solve the problem and prevent them from stopping the activity.

If the students had worked all together, they could have chatted "in live", that can be interesting.

freedom of strategies, communication & collaboration.

Teacher's A priori Evaluation of the unit

"Circle and perpendicular bisector as a soft locus" seems to me hardly exploitable by the students because it is very difficult to keep with the mouse, the point A at 6 units from the fixed point M in the case of the circle and the point P at the same distance from the endpoints of the line segment.

Regarding to the equation of the circle, it bothers me to have to write the equation in the form of $y=f(x)$ as the circle does not represent a function … and our Grade 11 students are supposed to know the equation $(x-x_m)^2+(y-y_m)^2=r^2$, while the Grade 10 students will never succeed to guess what this equation may look like since they do not know at all the equation of geometric object.

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Conclusion

- The first opinions after the priori evaluation by teachers are rather promising, tending to show that they acknowledge the potential of the resource to foster CMT in students.

- It is not that easy to draw a conclusion based only on the four responses.

- Further studies are necessary: not only a priori evaluation, but also test of the resource with students (planned for September 2016).

Thanks for Your Attention!