# Coaching and engaging. Developing teaching with CAS in High School

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*The extensive use of CAS at upper secondary school in Denmark provides a laboratory for research on the development of standards for CAS teaching. The poster focuses on action research into teachers developing lessons and student activities in an ongoing collaboration between university and high schools on use of CAS in mathematics teaching. Coaches[1] mediate design processes, reflection and documentation, and enable sharing. We discuss coaching as a valuable part of action research, and how to draw findings from the collaboration.*

## Danish CAS context

Starting with handheld devices in the 90's, the use of CAS in upper secondary math education has accelerated. A reform in 2005 opened for an extensive use of computers, resulting in a turn towards PC based programs used at school and for homework. Powerful CAS tools e.g. Maple drastically change the teaching environment but have only led to minimum adjustments in the final examinations since the earlier CAS-days. First-moving teachers *do* give access to own material, but there is no systematic sharing of experiences or standards for use of CAS in mathematics education.

## CMU's[2] agenda

Many teachers experience instances where CAS provides new insight or possibilities to handle more interesting or realistic examples. However, when allowed in the final exams CAS can turn math into merely an instrumental enterprise and thus trivialize mathematics education - a trivialization hard to see looking in from the outside. From the viewpoint of policy makers, school leaders, parents or even students one hardly knows what is missing. It demands insight to understanding that CAS *can* work in ways where skilled students learn less because tasks are too easy, while at the same time more disabled students are performing poorer, because they rely on a tool they do not know how to use. Addressing these issues lead to establishing CMU.

## Principles for coached teacher training

CMU collaborates with teachers interested in developing and sharing their experience with the use of CAS as an instrument for learning. We use a bottom up approach and draw upon models for

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[1] Coaches are high school teachers skilled in math and CAS, with some didactical knowledge along with social skills.

[2] CMU, Center for Computer Based Mathematics Education, Department of Mathematical Sciences, University of Copenhagen, Denmark, founded in 2013 with the support of The Danish Industry Foundation, Department of Mathematical Sciences & The Danish Ministry of Education.

action research (Asiala et al., 1996, Borba & Skovsmose, 2004), and designed a project management model accordingly (Figure 1). In Denmark teachers have wide latitude to organize their teaching, but a limited tradition for addressing teaching and learning in didactical terms. Through coaching - individuals or groups - we support teachers developing own ideas about mathematics with CAS. Our coaches play an important role in promoting teachers' reflections before, during and after teaching. Our goal is twofold: To call on teachers' experience and to promote teachers' professionalization (Dale 2003). We have designed a project report template for these reflections and the teaching material, and made the projects available on our website[3]. The coaches also assist in this documentation process.

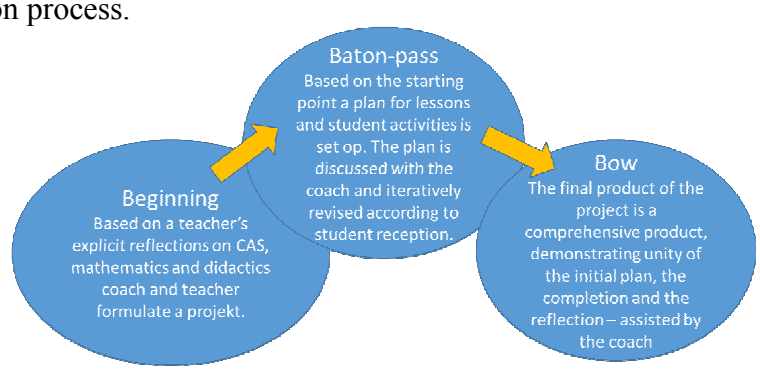


**Figure 1: Systems model for a CMU project**

At annual seminars, participants present their projects, goals and standards. It is essential to develop a common language and to understand how mathematical content and student activity changes in a CAS environment. From the discussions at our seminars, we can point to themes like:

- Which non-CAS activities should be introduced when working with CAS?
- How well should students know the CAS program in order to make real investigations?
- How can you work in ways that students both acquire useful skills and concept knowledge?

Research Questions:

CMU has a double agenda of promoting sound use of CAS and of in service teacher training. How does one draw *general* conclusions about CAS standards based on individual projects? Which teacher competences – CAS-specific, didactical and mathematical - should coaching promote?

**References**

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[3] http://cmu.math.ku.dk/projekter/