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# Teachers' strategic choices when implementing technology

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## Background

Teachers in Danish upper secondary schools are expected to independently plan and implement teaching, basing content and didactic approach on their own preferences - customized to student level, useful teaching materials, time spent etc. Use of technology - especially CAS – is extensive and reflected in tasks and techniques, in the sense of Artigue (2002), in both the classroom and within final examinations. The technological dimension changes the conditions for organizing teaching, which makes continued in-service teachers training an urgent need.

CMU has met these challenges by establishing a community of teachers and offering coaching to smaller groups or individuals, allowing for a dialogue that respects the teachers' wishes and needs while providing solid support in the process (Bang, Grønbaek, & Larsen, 2017a). Among the issues that we have identified during the coaching process are:

- The teachers' own mastery of the instruments – technically as well as educationally.
- Questioning how much the students themselves can do with the instrument in terms of time consumption, classes and student types, software for which the school has access, etc.
- The relationship between doing tasks with CAS and (also) doing without, expressing itself in many ways, e.g. which procedures you want to teach, what non-CAS assumptions you should have in terms of using CAS, and how work with CAS supports non-CAS work.
- Teachers' awareness of the relationship between procedural and conceptual development in a technological context, while respecting mathematical content in a longitudinal perspective.
- Standards for CAS responses opposed to non-CAS. The latter having a long tradition, while the first may depend on software, instrumentation, etc.
- Students' motivation - not least the motivation triggered by final exams.

## Fruitful aspects of the outsourcing metaphor.

The complexity of these interlaced issues involves many approaches, imposing a lot of theory on teachers not being one of them. We therefore need pragmatic ideas that can form a basis for dialogue with the participants and among the teachers themselves. Outsourcing (to technology/CAS) is to some extent used as a metaphor for how procedures that have been time-consuming maybe/may be advantageous with CAS. We have explored the concept, and its dual partner, insourcing, covering procedures and approaches done with or without technology, promoted in teaching (Bang, Grønbaek, & Larsen, 2017b). We are especially drawn to the control aspect, e.g. a company outsourcing procedures and thus losing control of them e.g. product quality, how the product fits in with the company's other production. Conversely, insourcing allows for control in the sense that you have clarity about qualities, resources, etc. Out-/insourcing can take place with or without technology.

## Interviewing teachers posting tasks for students on maps.

Based on the interviewee's generic teaching experiences e.g. 2nd degree polynomial, initial differential calculation, we asked her to post different tasks on a two-dimensional map (fig.1). The teachers quickly connected to the idea and although placing specific topics gave rise to discussion, e.g. possible placement in several places, there was rarely doubt about the general idea<sup>a</sup>.

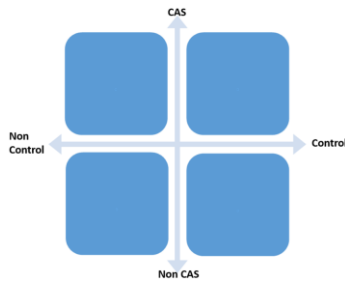


Fig.1

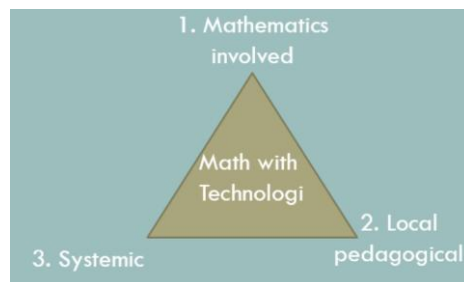


Fig.2



Fig. 3

## Identifying choices and research questions.

We have tentatively placed teachers' reasons for their choice in three interrelated categories (Fig.2):

1. Mathematics involved -derived from what promotes mathematics in a longitudinal perspective
2. Local pedagogical - approaches, that work in a specific class setting.
3. Systemic - approaches derived from e.g. requirements for examinations or grades.

Our RQs: How can analyses of teachers' choices promote better understanding of relations between (in-sourced) procedures and objects. What kind of activities with technology could stimulate interest in realistic mathematics? What kind of technology use at upper secondary mathematics is fruitful in a transitional perspective?

## References

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<sup>a</sup> One of the many tasks in question was the parallel shift of a parabola, e.g. to display formula for vertex. You can choose completely to outsource the procedure, but also choose to insource parallel shift of absolute value and do it by hand, or you can choose to look at Geogebra etc. to enhance students control of the procedure. A large part of the interview would be the teacher elaborating on their choice.