Roland Hachmann, Post-doctoral Researcher, University of Sothern Denmark
Stig Børsen Hansen, Assoicate Professor, University of Sothern Denmark

CT for All? *Computational Thinking in Danish Language Arts*

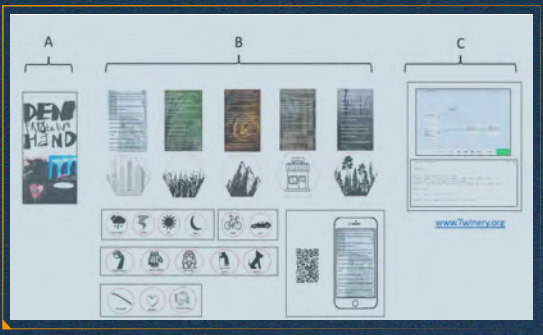

Figure 1: Elements of pedagogical design

Introduction: the basic challenge

This poster serves to 1) foster a conversation in the learning sciences community around materiality as a design constraint regarding pupils' computational thinking strategies, 2) document a design for learning computational thinking beyond a STEM context in primary school. 3) initiate a discussion of the reach and applicability, beyond computer science, of computational thinking. A key motivation for utilizing tangible things in designs for learning CT is the need to negotiate two ideas: That CT is an abstract mode of reasoning that can be applied in a wide array of settings beyond computer science (Denning & Tedre, 2019) and the idea that learning is situated (Lave, 1988; Dohn et al, 2020). The use of tangibles supports the latter point; the integration of tangibles with use of software supports CT as a more abstract form of knowledge. The use of CT beyond computer science can be framed as a matter of a new form of literacy that is fostered and exercised in different avenues (Kafai & Proctor, 2021), or as a matter of designing for transfer or transformation of knowledge and skills (Dohn et al, 2020).

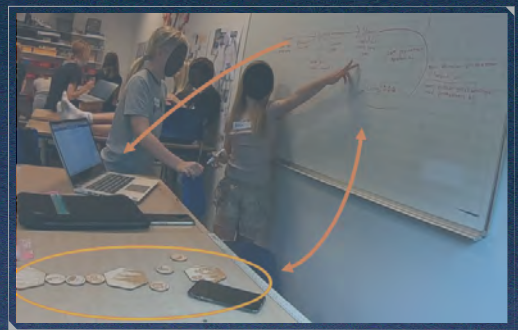

Figure 3: The wooden pieces are organized on the table, where they mediate the pupils' structuring and negotiation. They use the whiteboard as further support before writing in Twine.

Theoretical foundations: Computation, transfer and situativity

"Computation" can be understood as a mechanical process b performed on symbols for concepts as well as numbers. The manipulation of symbols for concepts has its roots in Ramon Llull's Ars, the numerical in Leibniz's thinking, and they were synthesized in Boolean algebra (Hansson, 2018). The conceptions share the notion that computation is a "mindless" or "mechanical" feature of thinking (Hansson 2018). Being mechanical, the task of thinking is transferred from a human to an external, physical piece of equipment or agent. Two aspects of computation are emphasised in this design experiment: The manipulation of concept-words, and the externalisation of thinking to something physical. This, in turn, is intended to facilitate pupils' computational literacy.

Traditional approaches to transfer (Gentner et al., 2003) as well as traditional conceptions of information emphasise the abstract character of transfer and information, respectively. In contrast, recent developments, both in learning (Levi, 2009) and understandings of information (Dourish, 2017) emphasised the importance of the material aspects of learning and information. As Dourish suggests, materials produce interesting constraints in computer science, and we follow Levi and others in proposing that they are equally of relevance to learning. The close integration of physical manipulation of concept-representations with use of software is motivated by these more developments.

The empirical study

The Design-Based Research (Amiel & Reeves, 2008) reported on here takes place in two Danish middle schools with pupils aged 10-12 (grade 4 and 5). First, the pupils were introduced to the beginning of a fictional text, The Horrible Hand. The story was read aloud in class as a starting point for the pupils to continue developing their own stories. To aid the pupils in this task, a tool (fig. 1) was developed consisting of 19 wooden pieces (5 large and 14 small), with different motives engraved into them. On the backside of the 5 large pieces, the pupils could access small excerpts of the original story (via a QR code to a homepage) picked by the designers. The pupils could use these as inspiration but were not forced to do so. Lastly, the pupils were asked to produce an interactive story in the open-source application called Twine (twinery.org).

Figure 2: Wooden pieces as structuring resources

Preliminary findings and discussion points

Finding 1: The tangible materiality of the wooden pieces (fig. 2) constrain the pupil's construction of the story to step-by-step sequences, both allowing them to decompose their ideas into smaller parts as well as arrange and re-arrange elements of their story in a meaningful way.
Finding 2: Further, the wooden pieces foster opportunities for pupils to develop new strategies for structuring the narrative in their stories. It points to a positive impact on the way pupils can survey and organize their text and adds both concrete and embodied experience and new forms of reifications (Wenger, 1998) to their negotiations of the different elements of their stories.
Finding 3: The tools (B) place requirements on the pupils' abstraction and literacy skill. Preliminary findings suggest that although the tools are material representations and constrain the writing process into smaller parts, some pupils need support.

Early indications for the next iteration of the design suggest that less firm scaffolding, carried out by the teacher, in the initial stages of the writing and ideation process increases the pupils' creative use of the wooden tools, resulting in more diverse and well written products.

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