The Cyber Weapon:
Escape Puzzles and Unplugged Computational Thinking with Computational Things

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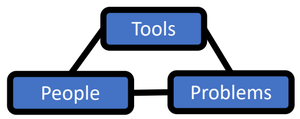
Framing the study

The empirical research sets out to investigate how tangible, computational objects influence pupils problem-solving from a subject-didactical perspective by addressing the relations between tools as subject-content, problems as ways of engaging into the subject through learning opportunities, and participation within the constraints of the subject. Selection of content, here computational objects, is a way of reifying the scientific disciplines of computer science, informatics, and design and to give way for subject related activities. In this sense, the pupils are not intended to be set on a path to become programmers, but rather to gain a basic understanding of what, in this case, decomposition is all about and how data processing follows specific algorithmic and sequential rules.



(Naur, 1967)

The Cyber Weapon is based on an open organization of puzzles combining different escape puzzle types such as pattern identification, searching for physical objects hidden in the room, team communication, manipulation of physical objects, strategic thinking, and ciphers. The open organization of the puzzles allows the pupils to take on several tasks simultaneously, giving them pieces, which must be combined to succeed in getting the code.

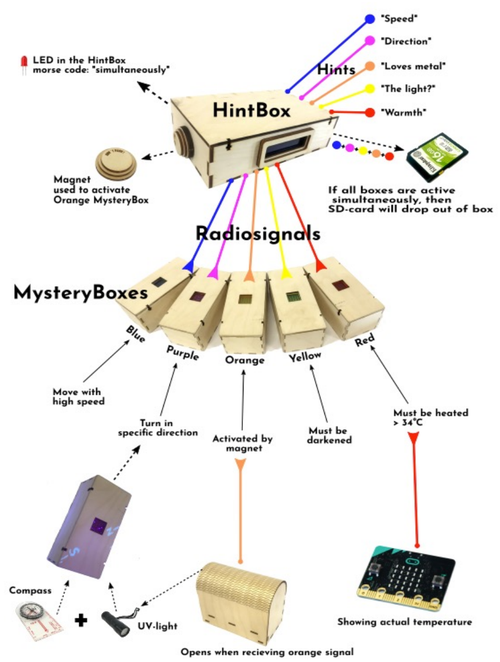
The RQ

How do tangible, computational objects impact the way pupils decompose as part of the problem-solving process?

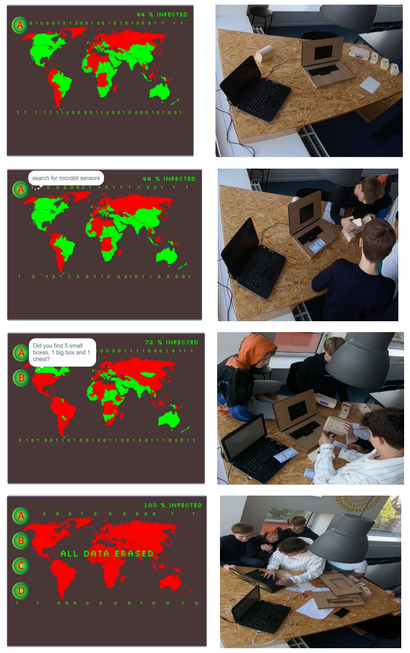
Methods

Video recordings of three different groups of pupils were analyzed and compared through specific focus on how the computational objects became "objects-to-think-with in the sense that they embed both cultural and subject-based practices and specific knowledge domains that affords and constrains learning opportunities.

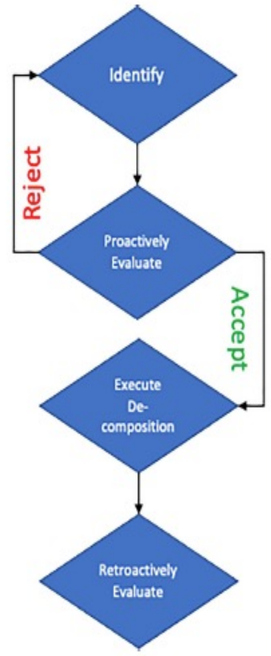
The Cyber Weapon



The activity



General decomposing



Lessons learned

Objects and their materiality play essential roles in a subject-didactical perspective because they frame what the pupils can do or cannot do when engaging in subject matter and related tasks. The physical and tangible forms of the computational objects play a crucial part in the pupils' way of engaging with the puzzles they face. They create opportunities for negotiations and concrete, bodily interactions that would be harder or even impossible to do on a computer alone or more through traditional ways of teaching .

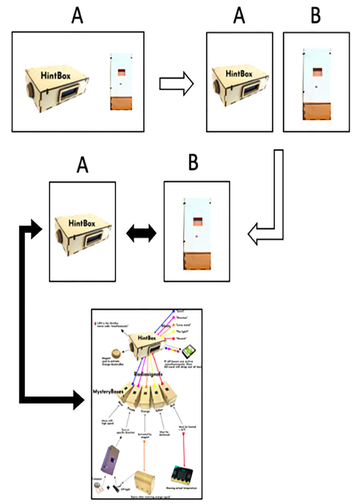
The Cyber Weapon as a narrative and the embedded computational objects frame specific ways in which the pupils perceive the problems at hand and how to solve them. Further as remarked by Kopcha and colleagues (2020) collaborative interaction with objects can foster the embodiment of abstract concepts that are part of the subject.

The potential of an alternative approach like the Cyber Weapon is that these basics of programming and problem-solving are learned and experienced through playful, explorative, and not least collaborative activities not bound to a computer or program, but indeed applicable to programming and other aspects of computer science.

Computational thinking is not a one-fits-all and a linear process and that decomposition is an iterative process throughout the whole activity. This contrasts with the more general picture of computational thinking as something occurring at a specific point of that process.

Designs like the Cyber Weapon reverbs the argument set by Lu and Fletcher (2009) about approaching computational thinking and programming through a more natural progression with a sensibility towards the pupils' prerequisites and dispositions.

Functional decomposition



References

Kopcha TJ, Ocak C, Qian Y (2020) Analyzing children's computationalthinking through embodied interaction with technology: a multimodal perspective. Educ Tech Res Dev. https:// doi. org/ 10.1007/ s11423- 020- 09832-y

Lu JJ, Fletcher GHL (2009) Thinking about computational thinking. ACM SIGCSE Bull 41(1):260–264. https:// doi. org/ 10. 1145/15390 24. 15089 59

Papert, S. (1980). Mindstorms: Children, computers, and powerful ideas. Basic Books.

Stevens G, Boden A, von Rekowski T (2013) Objects-to-think-with-together. Dittrich IY, Burnett M, Mørch A, Redmiles D (Eds). End-user development, vol. 7897. Springer, Berlin, https:// doi. org/ 10. 1007/ 978-3- 642-38706-7_ 17

Weller MP, Do EY-L, Gross MD (2008) Escape machine: Teaching computational thinking with a tangible state machine game. Proceedings of the 7th international conference on interaction design and children—IDC '08, 282. https:// doi. org/ 10. 1145/ 14636

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Read more

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