# Digital Skills & Computational Thinking

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TU Delft

# Overview of the workshop

**3 subtopics**, each topic = 10 mins presentation + 10 mins discussion

1. Why digital skills? What are digital skills?  - With Marcus Specht
2. What to assess and how to assess digital skills?  - With Xiaoling Zhang
3. Example of digital skills implementation in teaching and learning practices - With Hanno van Keulen

# Digital Skills & Computational Thinking

Marcus Specht TU Delft

# Different types of digital literacy interlinked

- **Digital Literacy**: How do we use digital tools for learning?
- **Information Literacy**: How do we search information? How do we integrate existing information with our knowledge? How do we evaluate digital information?
- **Data Literacy**: How can we work with data in different disciplines? How can we train students to develop skills for using and manipulating data in efficient ways?

- **Computational Thinking**: How can we solve and formulate problems using computational approaches and means?

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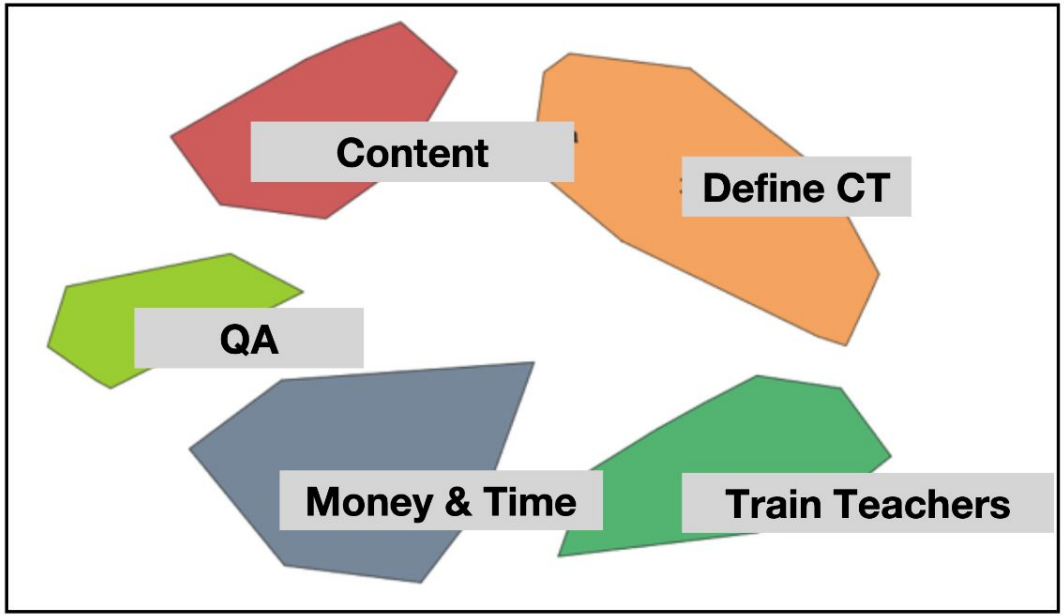
# What to do to embed CT in the curriculum

- Content of curriculum
- Definition and implementation examples
- Professionalisation of teachers
- Money and time
- Quality assurance

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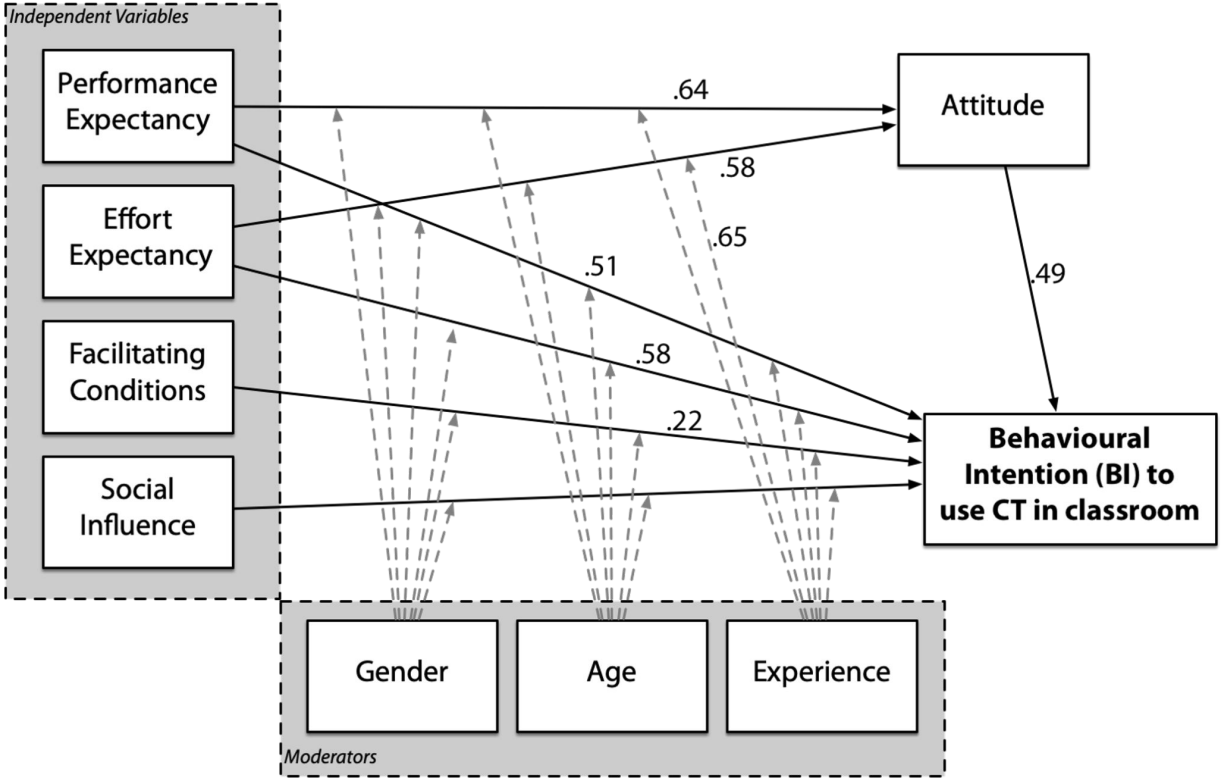
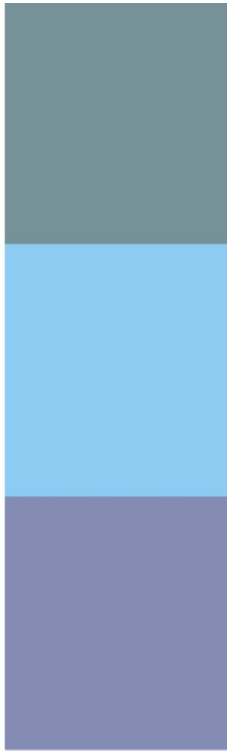
# How to engage educators ?



# Developing a long term vision on CT in HE

- Computational Thinking in the Engineering field also closely linked to hybrid engineering processes and AI
  - Hybrid AI is driven by scalable and non scalable processes
  - CT from a multidisciplinary perspective, computational methods, computer science, software engineering, design (Denning and Terde, 2019)
- "Tobacco Effects Research" of CT adoption coming from a generation C64, how can we undderstand what the long term effect of CT adoption is, do we have to do retrospective cohort studies to understand the outcome of a generation adopting ICT in the 80's



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# Developing a long term vision on CT in HE

- Long term vision has to be supported by different disciplines and faculty to have impact driven also by new academic and professional profiles
  - Collect current courses and implementation of programming education in different faculties

- Differentiate between Computer Science Education and general CT Education based on the vision but also identify related topics
  - We are not talking about making everybody a professional software developer!

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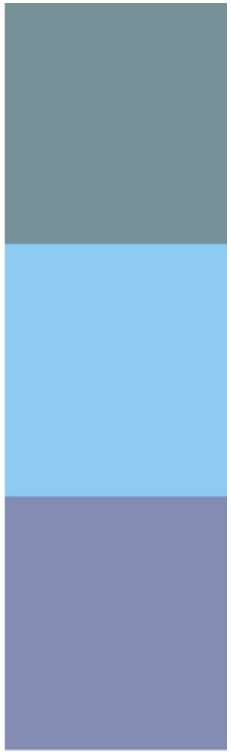
# Understanding CT impact multidimensional

- **Being digital literate** means different things
  - Digital literacy, digital skills, data literacy, information literacy
  - Awareness of tooling and possibilities, reshaping professional profiles
- **Motivation** to think computationally
  - Using IMI makes us understand subdimensions of motivation
- **Attitude** towards CT, adoption problems in secondary education
- Enabling hybrid **problem solvers** (Denning et. al, 2019)
  - Explanation of the world as patterns an hybrid processes
  - Automation of scalable processes in algorithms



# Examples and experiences in disciplines

- Mathematics: students learned about the data they were using and realized the value of using automation in the analysis as the data sets were too large to identify patterns manually
- Music: programming in music and the use of online data (e.g., HookTheory.com) and Python code to explore music released by a popular artist and algorithmically write a portion of a song in the style of that artist.
- Sociology: students researched and selected websites aimed at promoting and selling toys to children. Their task was to identify patterns such as slogans, colors, music, and activities associated with gender.



Pollock, L., Mouza, C., Guidry, K. R., & Pusecker, K. (2019, February). Infusing Computational Thinking Across Disciplines: Reflections & Lessons Learned.In *Proceedings of the 50th ACM Technical Symposium on Computer Science Education* (pp. 435-441).

# Digital Skills & Computational Thinking

Xiaoling Zhang TU Delft

# Assessment of Computational Thinking (CT) in Higher Education

# What is Computational Thinking?

# Interactive

- What comes into your mind when mentioning CT?
- What assessment methods are often used in teaching and learning practices?

https://www.menti.com/aluptcmdu68s

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# What is Computational Thinking?

A set of *problem-solving skills* to

formulate a solution to a problem

executable by

any information processing agent.

(Wing, 2006)

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# Assessment of Computational Thinking (CT) - Overview

- Digital Skills
- **Computational Thinking**

- Assessment **context**?
- **What** to assess?
- **How** to assess?

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# Focus of my PhD project

- Assessment **Context**
- **What** to assess?
- **How** to assess?

- Higher Education
  - Both CS and non-CS major
  - Promote the idea of CT for all

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# Preliminary Results

- Assessment **context**?
- **What** to assess?
- **How** to assess?

- Assessment **Context**
- **Assessment Constructs**
- **Assessment Methods**

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# What to assess?

**Most Frequently Assessed Constructs**

**Lu et al., 2022, Hybrid Framework**

**CT Concepts**

- Algorithm / algorithmic thinking / algorithm skills
- Data / data analysis / data collection, data analysis / data representation
- Automation /automating solutions
- Logic / logic and logical thinking
- Critical thinking
- Evaluation
- Pattern / pattern recognition
- Synchronization / synchronize

**CT Practices**

- Abstraction
- Problem-solving
- Modularity / Modularizing / Modeling
- Testing / testing and debugging

**CT Perspectives**

- Creativity and creation
- Collaboration and cooperation

**More than *100 unique constructs* were identified!!!**

**S1: Literature Review**

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# How to assess?

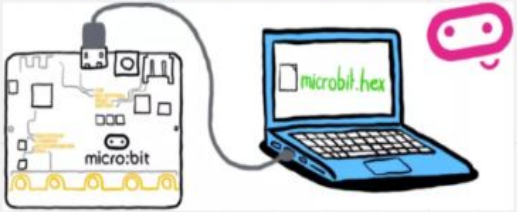
**Assessment Methods**

- **Knowledge/skill written tests, self-reported scales/survey**

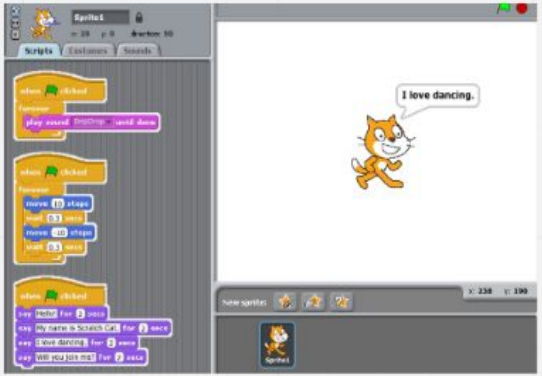
Dolgopolovas et al. (2016). - CT Test
Leonard et al. (2018). - 4-point Likert-type scale

1. Computational thinking is understanding how computers work.
2. Computational thinking involves thinking logically to solve problems.
3. Computational thinking involves using computers to solve problems.
4. Computational thinking involves abstracting general principles and applying them to other solutions.
5. I do not think it is possible to apply computing knowledge to solve other problems.
6. I am not comfortable with learning computing concepts.

- **Robotics/game-based assessments**




- **Block-based assessments**




- **text programming -based assessments**

- **Combinations** (rare, but wanted)

S1: Literature Review

# Take away messages

- No standardized assessment.
- No benchmark for quality check.
- Discussion on proper assessment design needed.

## Teachers wanted!

A 10 minutes' survey to help us reflect on digital skills education.

**Link** https://tudelft.fra1.qualtrics.com/jfe/form/SV_egFndjtwP6Ljfvw

**Scan QR code here:**

We, together, lead education further!

| | |
|---|---|
| How? | Link or QR code, it is of your choice (both provided above)! |
| Who? | You! Yes, teachers who teach at Higher Education! |
| Why? | Your view on Computational Thinking (CT) skills is important for advancing education. |
| What? | Your view on integration of CT skills & CT skills. |

For more information, please contact Xiaoling Zhang via X.Zhang-14@tudelft.nl

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# Questions for audience

- Regarding assessment of CT in higher education, what is your opinion over:
  - Who to be assessed?
  - What to assess?
  - How to assess?

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# Digital Skills & Computational Thinking

Hanno van Keulen TU Delft

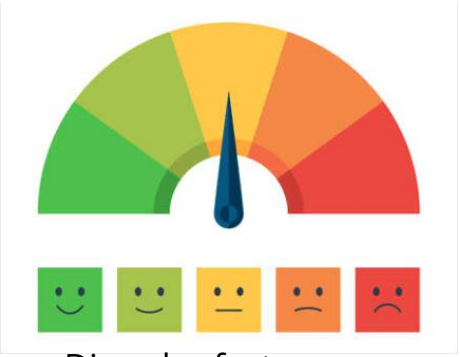
# Presentation - Examples of Implementation in Teaching

1) Virtual Reality for classroom management in teacher training (currently under construction)

2) Robotics as a means to improve collaboration skills for students with Autism Spectrum Disorder

# 1) Virtual Reality in Teacher Training College to train classroom management skills

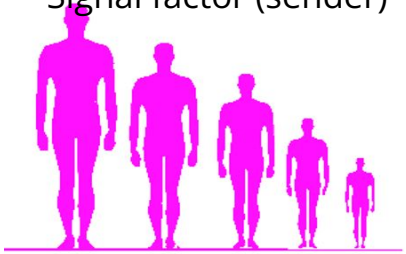
# Disorder as a function of sending (teacher) and receiving (student)



Disorder factor



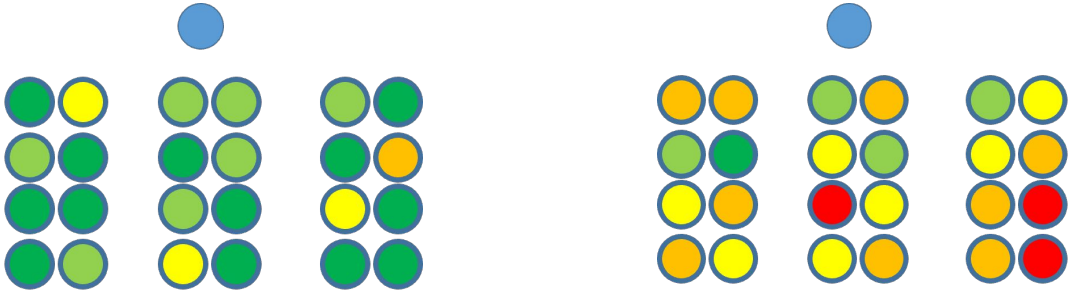
Signal factor (sender)



Receiving factor

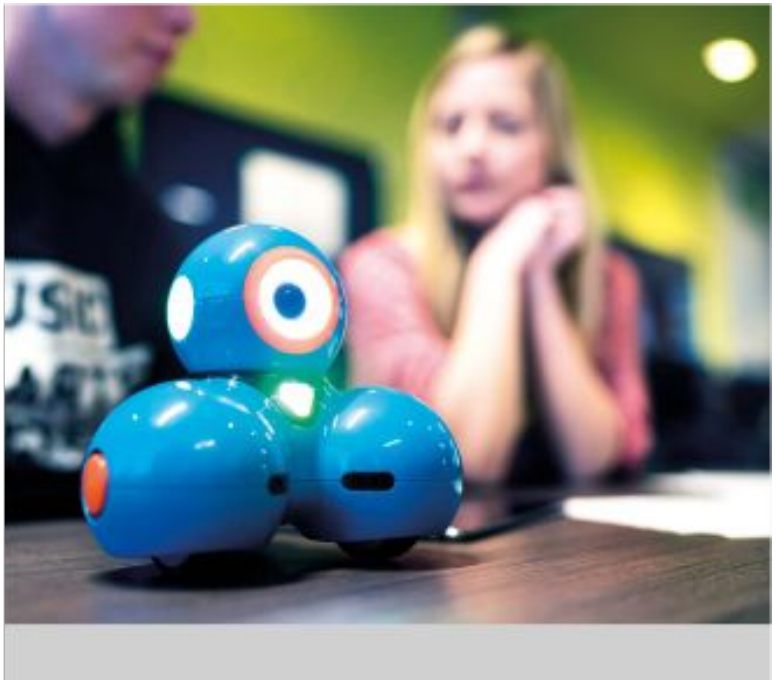
Avatar students in the VR zone get (variable) values for their dispositions towards ‘disorderly behavior’ and ‘willingness to receive the message of the teacher’

The (student) teacher chooses a scenario (a teaching style with a level of authority and ‘sender’ ambiguity) and enters the VR zone

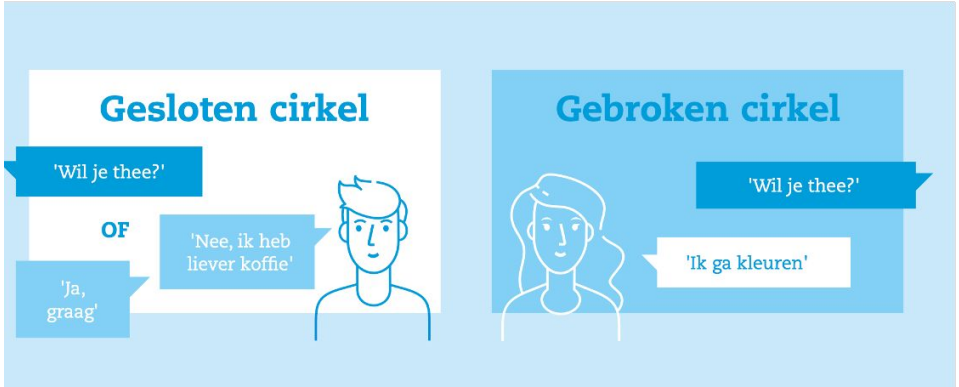


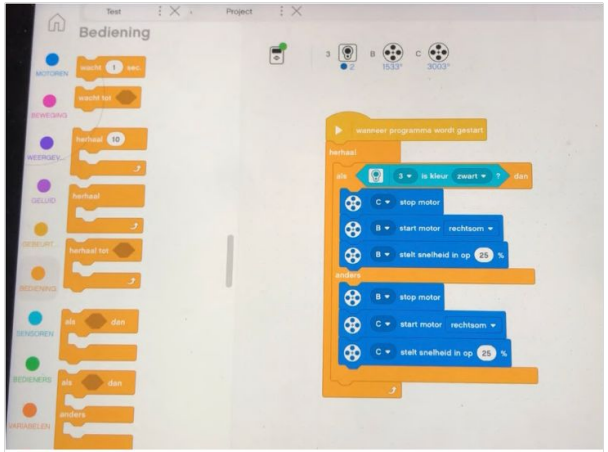
A (virtual) quiet class (left) can become a (virtual) disorderly class (right)

# 2) Programming a robot to develop social skills in children with Autism Spectrum Disorder

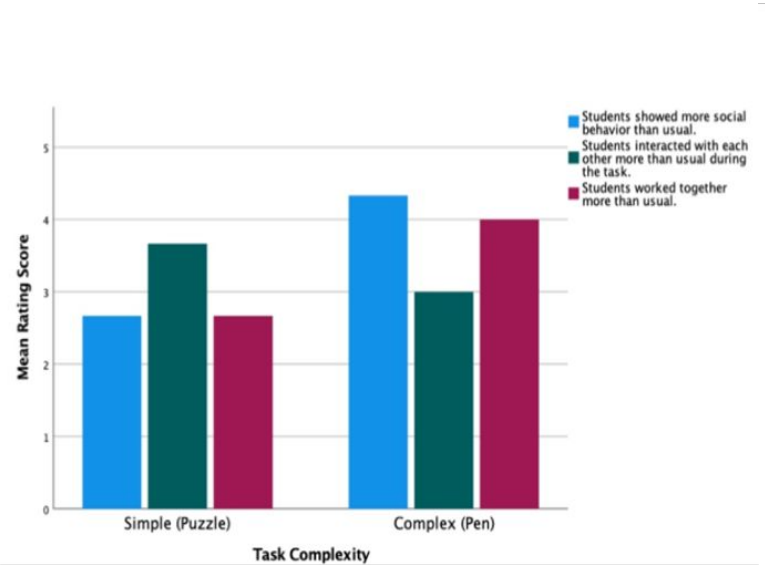


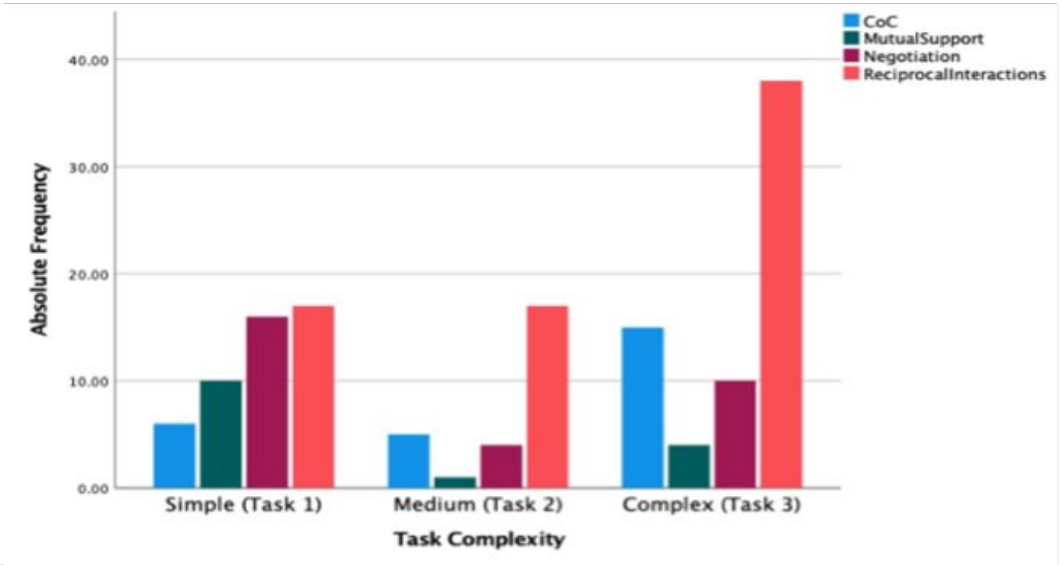
# Communicating about the robot and the program



# Robotic challenges need to be in the 'zone of proximal development' to trigger collaboration



# Discussion - Example of Implementation in Teaching

- How to develop teachers (in primary and secondary education) from anxious consumers of digital gadgets to literate producers of digital skills?

- How to support schools in the area of computer science when almost no computer scientist aspires to become a (full time) teacher?