Defining procedures in early computing education
one probe in the ScratchMaths research

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Background

- defining procedures – a key instrument of computational thinking
  - instrument of abstraction
  - instrument of generalisation

- Papert (70s, 80s): a metaphor of *teaching the Turtle a new word; powerful idea*

- the construct of a procedure – key issue in CS since its beginning
  - a name for a compound element of a language (Abelson, Sussman, 1985)

- many renewed computing curricula recognize
  - the importance of procedures in computing education
  - a pattern to control complexity (CAS)

- educational research since 80s
  - points to some inherent cognitive difficulties with this concept
Scratch and procedures

- Scratch: an icon in computing education
  *with brilliant support for iteration, variables, conditions, broadcasting...*
  *but: procedures not implemented in Scratch 1.4 (2007 – 2013)*

  Maloney et al: ... *users were confused... since procedures seemed very similar to broadcasts*

- Scratch 2.0 (2013)
addresses mathematical thinking through programming primary computing curriculum – Y5 and Y6 (9 to 11 year olds) involves 100+ English primary schools has developed intervention for 20+ and 20+ lessons new pedagogical approach (5Es) which structures the intervention Explore, Explain, Envisage, Exchange, bridgE professional development for 200+ teachers extensive teacher support materials IWB slides for every lesson additional challenges, vocabulary and reference posters
ScratchMaths strategy for *procedural abstraction* in 5 stages

... winds systematically through all 6 SM modules, deeply integrated and exploited

1. Perceiving a script as an object to work with and think with
2. Giving a name to a script
3. Working with new blocks (first provided ones, then our own)
   e.g. using a new block inside the definition of another new block

4. Customising and duplicating definitions
5. Generalising definitions by indirect parameter

... continued
Searching for deeper understanding

☐ SM interventions as an instrument for research

*RQ1*: Which factors play role in pupils’ understanding and utilizing the construct of procedural abstraction?

*RQ2*: Which computational procedures need to be mastered to support pupils’ understanding and exploiting the mechanism of abstraction ...

☐ observations during the design research process
  some initial issues
  resulted in several improvements of the intervention

☐ content analysis of the final assessment Scratch task
  after 6 modules at one of the design schools
Final assessment task

- teacher demonstrated the final behaviour

- class as a group (in front of the IWB) discussed the activity
- a starter Scratch project provided... *with a sprite, its setup script predefined “set random ... “ blocks the side length variable already there*

- pupils working in mixed ability pairs for 70 minutes
  we collected 9 projects of 21 pupils
Nesting analysis

- focusing on overall functionality, definitions and their nesting (stage 3 of SM)
- indirect parameter answer and side length properly used in the definitions (stage 5 of SM strategy)

- topmost triangle ... overall behavior
  filled, semi-filled or empty – correct, partially correct, incorrect
Discussion and concluding remarks

- RQ1: main factors: appropriate, systematic and consistent pedagogy stage 1 to 5; language affordances
- Transforming materials from Scratch 1.4 to Scratch 2.0 is not sufficient
- Definitions play different roles in the pupils’ scripts: aggregation, extension, transformation, patch
Thanks for your attention

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References
- Benton, L., et al. (2017) Beyond Jam Sandwiches and Cups of Tea: An Exploration of primary pupils Algorithm Evaluation Strategies (manuscript to be submitted)