Universität Bremen

# A scaffolding step: Haptic actions integrated into a technology-based embodied design

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DeciPlace

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AG Didaktik der Mathematik

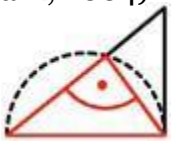
# What is DeciPlace about?

Empirical evidence about:

- „misconceptions“ while dealing with decimal number (transfers from natural number and fractions)
  (see Resnick et al., 1989; Heckmann, 2006; Steinle & Stacey 2004)
- predominantly procedural dealing with decimal numbers
  (see Hiebert & Wearne, 1985, cited in Roche & Clark, 2004, p. 486; Resnick et al., 1989)

Extension of the decimal number system from natural to decimal numbers by continued debundling is fundamental for initiating conceptual understanding of decimal numbers

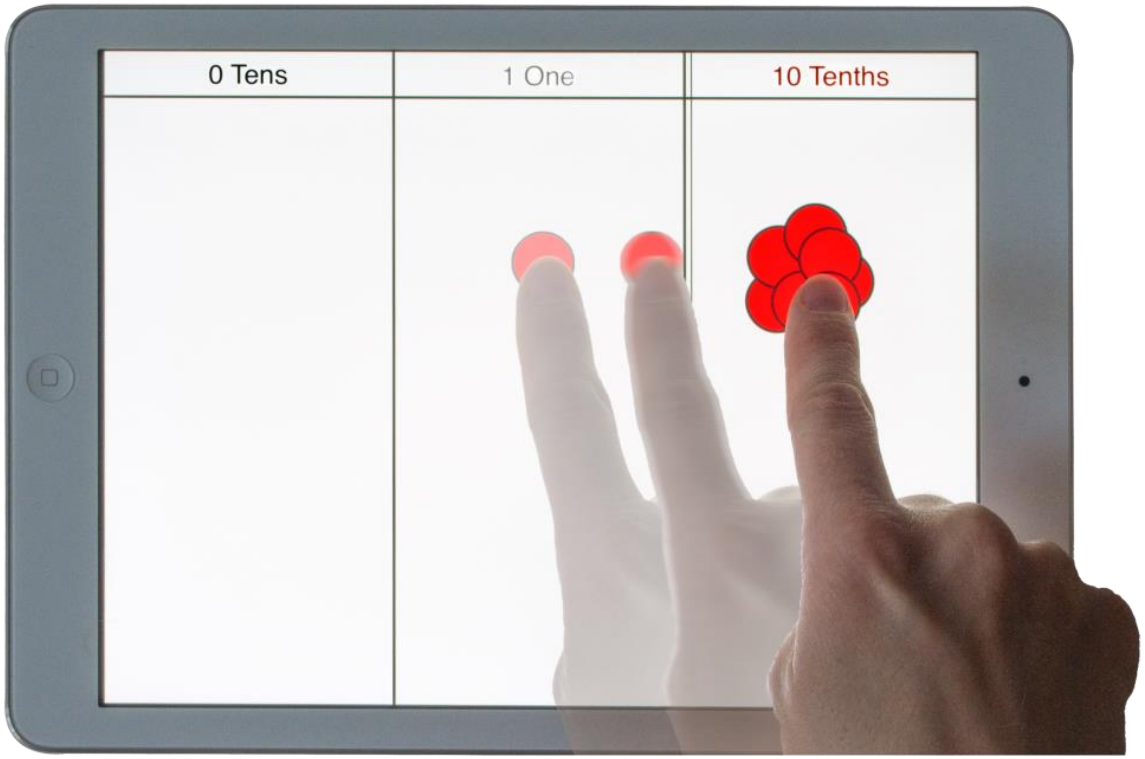
(see Heckmann, 2006; Steinle & Stacey, 2004; Roche & Clark, 2004)



# Aim of the study

**Aim:** Examining the potential of a digital place value chart (DPC) on the iPad to constitute the decimal numbers' structure based on the place value system's structure

Itunes-App: "Place Value Chart"
(designed by Ulrich Kortenkamp)



# Research design

**Design-Based Research:**

- Designing tasks

  Extension of the decimal place value system from natural to decimal numbers focusing on bundling and debundling

  e.g. finding & matching different partitions of the same (decimal) number

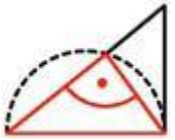
- Conducting design experiments

  17+6 student pairs, grade 5 & 6, video-recorded

- Examining the epistemic process of students

**Theoretical approach:**

Students' process of constructing mathematical knowledge as carried out in a multimodal way (semiotic bundle – Arzarello, 2006) in social interaction (GCSt-model – Bikner-Ahsbahs, 2005)

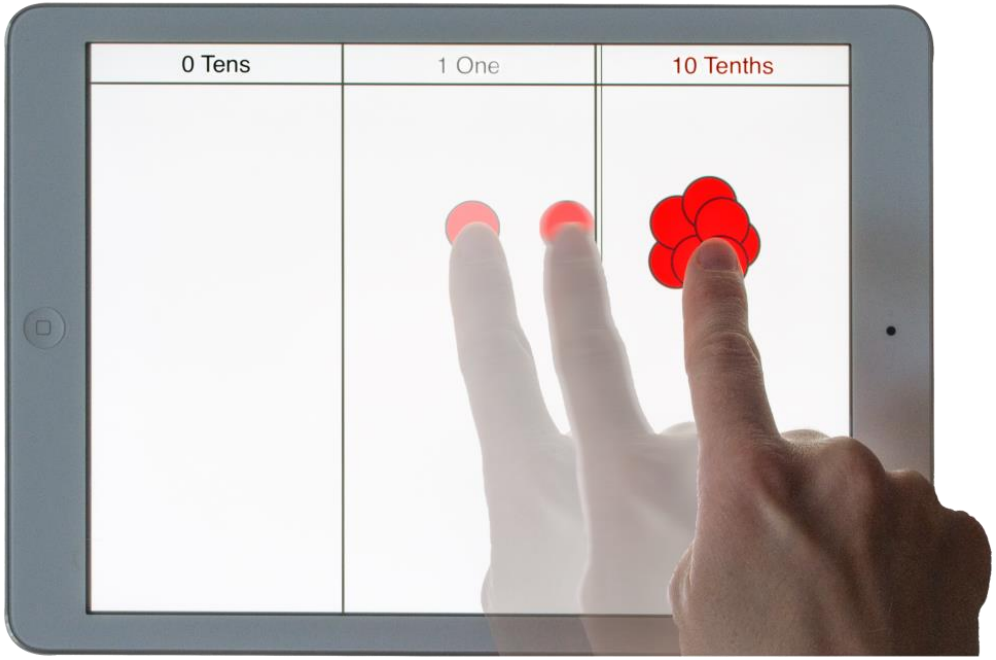


# Hidden meaning of debundling

Debundling as “one becoming ten” (distal movement in speech) when “dragging a token” (proximal movement in speech and gesture)

*Why did the inventor of the digital place value chart made ten out of one ones?*

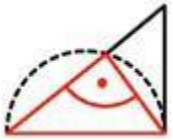
James: “So that it is always ten when you drag a higher one there.”

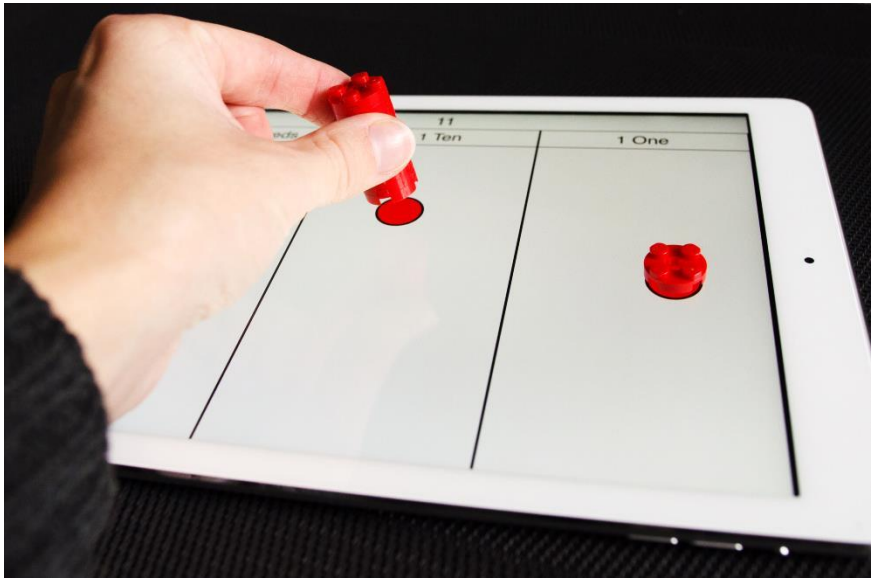


# Adding meaning to debundling

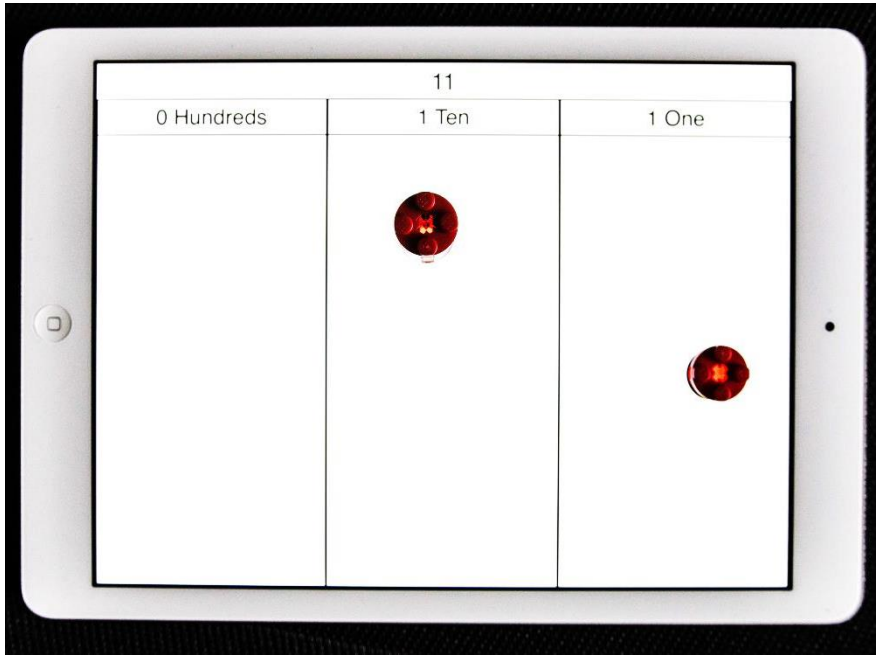
How could we make bundling and debundling in this embodied design mathematically meaningful?






11
1 Ten
1 One


0 Hundreds
11
1 Ten
1 One


11
0 Hundreds
1 Ten
1 One


11
0 Hundreds
0 Tens
11 Ones

# Adding meaning to debundling

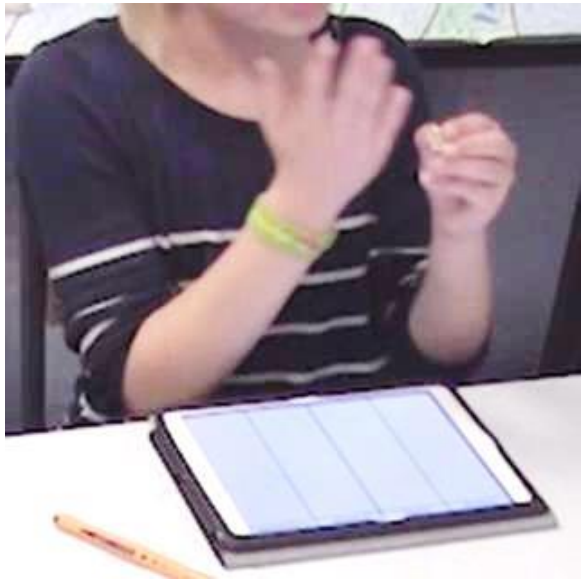
*Describing tenths:*
"… he divides it into ten halfs"
"… we divided into ten parts"
"… it [one ones] is divided into ten"
"If you would pile the tenths ten times, it would be one ones."

*Why did you/the inventor of the digital place value chart made ten out of one ones?*
"… it is logical, it is always divided by ten"
"One ones is again divided into ten parts"
"…because there are ten inside."

# Adding meaning to debundling

**Hundredths:**

Charlotte: “We would have to divide this (*points to a piece of Lego and takes it*) into 100 parts (*cutting-gesture, see below*). The only problem is, that it is so small, that, I think, we cannot make it.”



# Conclusion

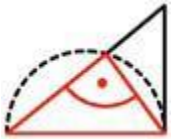
Integration of haptic actions into the students' interaction with the DPC by

(1) modelling the 2D-tokens as projections of 3D-towers and

(2) providing material 3D-towers for their haptic partitioning into ten equal parts

...in order to make the embodied design mathematically meaningful

Idea of partitioning into ten equal parts is integrated into the concept of de-bundling as an add-on-meaning that allows the extension from natural numbers to decimal fraction preserving the principles of the digital place value system



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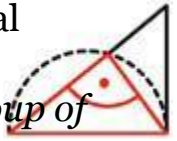

# Thanks for your attention!

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