Walking geometry: Using location-aware technologies to change the scale and modality of mathematical understanding

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Scale, place and embodied mathematical experience

Conventional school geometry...

relies upon a *generative* relation between symbolic /graphical forms and physical models at graspable scale.

privileges *extrinsic* (POV from outside) over *intrinsic* (from inside) experience and imagination.
If geometry were *also* taught and learned at a walking scale, could we...

- highlight *relations* between extrinsic and intrinsic aspects of mathematical experience?
- use changes in scale (and tools) to create different possibilities for activity, experience, and understanding?
Does changing scale matter for mathematical experience?

Conceptual understanding is “grounded” in modality-specific traces of body experience.

Space is not isotropic in experience, but a composite of:

• personal space (proprioceptive),

• peripersonal space (graspable, extended by tools), and

• extrapersonal space (pointing, gaze following)
“It is not down in any map; true places never are.”
Herman Melville, *Moby Dick*

Jeremy Wood on drawing in London: The word “DOWN” was written in a cemetery. The quality of line is quite jagged since there were lots of sharp turns to negotiate to avoid the tombstones. The “D” started at the iron gates at the entrance, I turned left off a pebbled track, crossed the lawn over a dried up pond, continued round beyond the crematorium and along past memorial stones, gardens, and benches, and back to the gates.

http://www.gpsdrawing.com/gallery/land/meridians.html
Walking scale geometry task

- pre-service secondary math teachers worked in small groups
- picked region of campus
- constructed geometric object
- performed a series of transformations (rotation, dilation, translation)
- displayed drawings to classmates using Google Earth
- guessed/discussed how objects were constructed, transformations performed
- data include drawings, written reflection, interview and video recording of re-constructed drawings
Walking geometry group products

SHAPE group
- draws rectangle & circle
- disappointed with precision

NAME group
- writes “PAUL” across the “heart” of campus
- discovers scale inconsistencies and omissions in campus map

CLEF group
- draws musical clef on baseball field
- discovers extended analogy between geometry and marching band
Constructing a musical clef

• paper (23 x 15 cm) vs. baseball outfield (20 x 30 m)
• durable marks vs. marks hidden in device
• symbolic labels, fine-grasp, arm movement vs. bodies deployed as place marker, reeling in rope, moving stylus
• extrinsic POV on whole (above) vs. partial intrinsic POV (within)
• gestures fit figural scale vs. pointing and gaze following
• individual actions vs. required multi-party coordination (marking, handling rope, moving stylus)
• talk optional vs. talk required for coordination
Are line segments ‘held’ in the body?

...while re-membering the clef

You use a compass to measure things?

It was the same distance no matter where you were standing?

I realized that- it can change length?

...while re-constructing the clef

We can’t make it that big.

I’m gonna go until HERE.

re-membering appears to involve modality-specific traces of personal body activity
Interplay between practices of geometric construction

Like in geometry class that- I'm in with Becka. We have to use compasses- I never thought about this before [this class. You use a compass to measure things?

We can't make it that big.
I'm gonna go until HERE.

intended (by us)
discovered (by them)
Does changing scale matter for mathematical experience?

Shifting from paper to walking scale changed *what could be seen* (POV) by participants and *how they used their bodies* over time and space.

Changes in scale placed new demands on talk as a means to coordinate imagination (*extrinsic and intrinsic* POV), tool use, and body motion.

The participation structure of walking geometry must, itself, model (re-present) participants’ geometric imagination.

The CLEF group illustrates intended and discovered aspects of interplay or transfer at a collective level of analysis.
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