The Child Tangible Interaction (CTI) Framework

Informing the Design of Tangible Systems for Children

Dr. Alissa Antle

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Motivation

How can we move past documenting individual design cases …

and move towards building generalizable design knowledge about interaction which has utility for a general class of problems involving tangibles?

How can theory inform the design of tangibles to support cognitive and/or socio-cognitive development in children?

How and why does tangible interaction support children's cognitive development?

The CTI Framework is relevant for …

Play-based tangibles which support school age children's cognitive and socio-cognitive development in the area of spatial cognition and abstract reasoning.

May generalize beyond …

Design Frameworks can be used to …

Inspire designs

Articulate areas which require special consideration

Provide understandings about these areas

Support analysis

The Child-Tangible-Interaction (CTI) framework is …

At worst … the articulation of a group of concepts which may have utility in interaction design for this class of problems.

At best … the articulation of a group of concepts and their relationships which have explanatory power and are important to consider in successful interaction design for this class of problems.

DEVLOPING THE FRAMEWORK

the simple version

1. Identify “important” properties of tangibles
2. Identify “relevant” theory from children’s cognitive development research

1+2 + empirical work =

design considerations

Prototypes are …

research instruments

through proof of concept(s)

allow us to explore the utility of theoretically-derived design considerations

in interaction design.

…. and secondarily, prototypes are solutions to design problems.

VALIDATING THE FRAMEWORK

We can assess the quality of a method for representing a user group in design like we can assess research methods social sciences [Antle, 2007].

Does the model provide an objective, reliable and valid representation of what's going on with children during tangible interaction?

Triangulation: getting the model out to other designers is critical.

Excerpt …

TANGIBLE SHAPES PROJECT

Tangible Tetris

Problem Identification

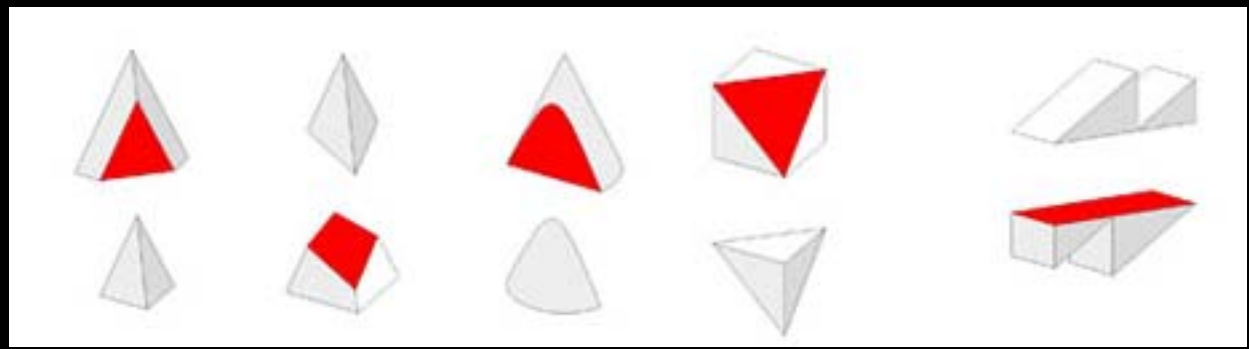
Online questionnaires to teachers in regular, inquiry-based and Montessori educational programs

Areas where children have difficulty with knowledge acquisition in a spatial, temporal or mathematical domain.

Developmental Difficulty (problem)

Spatial visualization

Interior of 3D geometric shapes



What do we need to know to support spatial visualization tasks related to geometric forms?

1. Property of tangible interaction
   …offers space for control through direct action

Anderson 2004 Lund 2005

How can ACTION help in spatial visualization tasks?

Tangibles provide opportunities to support epistemic actions.

[Klemmer & Takayama (2006) and others]

Epistemic actions are actions that we take to manipulate the environment to change the nature of the cognitive operations required to solve a task.

Clue 1. Epistemic actions are one way in which children (and adults) develop mental cognitive skills.

Clue 2. Epistemic actions which offload a mental task to the environment make the task easier.

Design problem becomes …

supporting children to turn the mental spatial visualization task of imagining interior sections to some other task which is easier …

Properties #2,3,4 … Representation

Tangibles provide opportunities to manipulate the mappings between physical and digital representations.

Tangible have:

2. Perceptual mappings
3. Behavioral mappings
4. Semantic mappings

How can semantic mapping between different representational forms help?

As children develop spatial cognitive skills, there is a relationship between cartographic map understandings and their developing spatial skills.

There is reciprocal development of the mental spatial visualization skills and the use of maps.

[Liben 2001]

Clue 3 → Design problem becomes …

supporting children to “offload” the mental task to a task that involves manipulating tangible representations which is easier and will still help them develop the visualization skills.

Maybe we should explore if any of this works in real life …

Mental visualization becomes tangible pattern matching

Oscar’s garbage can

Cylinder or Block?

The problem with representations

from

Why manipulatives don't work [Uttal, 2003]

based on

The incredible shrinking room problem

[DeLoache 1998]

Understanding interior sections which are not the same as a face.

Visualizing becomes physically cutting

and then pattern matching

Test children using analog prototype with cutters, clay, project images, visual and verbal feedback

Results: Ten 7 year old's performance exceeds curriculum expectations within 20 minutes.

And yes, children are engaged and have fun.

Conducted two more user studies

Now specifying a tangible 3D Tetris with virtual cutter using RFID, touch table top and orientation sensors.

Framework under development

My TEI paper attempts to articulate some design considerations.

How to do more than articulate and illustrate the concepts?

Looking for commonalities … other prototypes

Aibo – analysis of children's collaboration in multimodal problem solving

Music tunnels – supporting children to replicate and create temporally variable musical patterns using a body interface

So …

How can developmental theory inform design?

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