IAT 882 version → Why Tangibility Matters – sample paper presentation – taken from CHI 2017 presentation adapted to 882

PhonoBlocks reading system project.

Change from CHI presentation to IAT 882 seminar lecture to reduce detail for more general audience than at CHI session on learning/TUIs and to ensure covered presentation template section 6.– critique of the work in detail.

TITLE SLIDE: Tangible user interfaces have been designed for a variety of domains. Many of which have been spatial like geometry or interior design. **A research gap exists in the domain of TC --** to move the field forward we need to investigate if tangible user interfaces have benefits in non-spatial domains.

CLICK -- TUI SLIDE: In our paper we present a study in which we are exploring if physical and spatial properties of tangibles might help young children struggling to learn to read and spell.

CLICK READ ACQUI: **In addition to grounding our work in the domain of TC and Iny design -- We draw on work in the domain of learning, in particular early ready acquisition.** Success in early reading acquisition requires that young children learn the alphabetic principle, this is **concept** that letters represent sounds which form words according to rules.

Although you might not have thought of it letters are symbols that are spatial – they occupy two- or three dimensional space depending if they are printed on paper or objects and words are made up of linear combinations of letters where the position of letters matters to the sounds they make.

SLIDE: People who have a severe difficulty learning to read – called **Dyslexia** -- make up 10% of population in English speaking countries -- many of them never learn – resulting in enormous social, emotional and economic costs.

There are three main causes of this difficulty – **each involves a theoretical concept –about why children are** struggling to learn to read … they

1. have trouble hearing the sounds that letters make – this is called **phonological awareness** – required to learn alphabetic principle
2. They often have **attentional challenges** – impact learning
3. English is particularly difficult to learn b/c the language is **opaque** – this means that one letter can make a variety of sounds depending on the other letters in the word with it.

RQs: So our **applied research problem** is to determine if the properties of a tangible user interface improve the process and outcomes for children w/ Dyslexia earning to read and spell in English.

There are two **main research questions** in the paper

The first about the outcomes – Do children improve word reading and spelling after instruction with our TUI reading system?

The second is about design knowledge … What are the key TUI design factors that benefit children?

VIDEO DEMO →

They key design features of PhonoBlocks are -- Children interact with it using **3-D tangible** letters. The letters have **embedded** LED strips that can **change the colour of the letters**.

Putting these features together, we can provide **dynamic colour to cues that draw attention to the moment that adding a letter changes the sounds in a word**. This is the core concept and design feature in our design that we expect will be beneficial.

Some other non-TUI features: blend, picture, word list.

How the system works -- The letters are placed into slots on a word making interface where magnets snap them into place and complete the electronic circuit.

The letters act as input to a custom reading app – that provides audiovisual feedback as the child makes words.

There are six spelling rules – which will **be the tasks in our user study.** Look at two …

1) Blends -- Two adjacent consonants turn green to show that they make a blended sound fl in flag.
2) Magic E -- When a trailing E is placed, the letters flash to red to draw attention to how the E changes the letter A's sound in the word making gam into game.

END Video: at 1:00

METHODOLODY SLIDE We used a **case study methodology** so we can look at each child individually in detail.

We worked with **8 children**, 5 boys and 3 girls, average age 7.3 years– selection criteria -- by now teacher's realized they are struggling readers – The children had **failed to progress** with their grade ½ class reading instruction and failed to progress with pull out sessions with the school's specialty reading resource teacher.

Each child had 12 facilitated sessions pull out in a small classroom in the school – 2 for each of our 6 rules – first part tutored instruction and then children practiced words for each rules.

SLIDE PROTOCOL: Prior to using the system, the children received a **Reading and Spelling pre-test** for baseline data for **accuracy**. Then each child received one-to-one training sessions over a month which were **video** recorded.

The **reading and spelling post-tests** included the words they had been trained on and also new words that followed the six rules. The new words ensure that children can **transfer** their learning to other words.

The children also received a **follow up reading/spelling** test one month after the post-test. Again they were tested on trained and new words. The follow-up test is important to see that children have **maintained** their learning over time.

RESULTS Here's what we found out.

QUANT/ GRAPH READING The most important quant data was each child's was raw score on tests of reading out loud and spelling by printing words on paper. We used a within group analysis to look for a change from pre-to post to follow-up test. Reading was out of 36 words.

For reading we saw that there was a significant increase at the P .01 level on participants' scores on trained words between the pre-and post-test and no change to the follow-up test. Shown in Blue.

Children also transferred their understanding of the six rules to new words shown in turq – we see that on the new words children performed similarly as they did w/ trained words

And this learning was maintained with no significant change at the follow-up test.

GRAPH SPELL

We see similar results for spelling.

Children's scores on trained words increased at the P=.01 level between pre-and post-test and held stable at the follow-up test (green) trained and new words.

VIDEO QUAL (1:04 – 3:00 – 2 minutes).

As designers – once we see these this kind of evidence of learning gains – then we want to know why/what was it about tangibility/if anything/ that mattered.

QUAL FINDINGS Our Thematic analysis of video revealed six interactional behaviors which we know are beneficial to the process of learning.

Video –

1. The colour change draws children's attention to that moment when adding letters changes the sound of the word.

2. We also see two-handed interaction with the physical letters. Placing the letters is much easier than printing and so we reduce cognitive load by teaching children to read and spell separately from teaching them to print.

3. The letters have a physical constraint – a little notch on them and this helps children determine the correct letter orientation – avoiding letter reversal.

4. Non-computational work with 3-D letters blocks has shown that touching and tracing letters help children learn – we see evidence that w/ PB.

5. Children organize the letters for each learning task to make the task easier later. This is called epistemic strategies. Here she's organizing pairs of vowels that go with the letter R ahead of time.

6. When children are still learning a rule we saw that they use a single hand to place the letters one at a time. But once they have learned the rule they use two hands to place the letters that go together at the same time – this makes their learning visible to the facilitator.

SLIDE DESIGN → **three main design implications** what have we learned?

1. Using dynamic colour cues embedded in 3-D tangible letters to the children's attention to letter sound correspondences.
2. The 3-D letters and work space enabled epistemic organizational strategies which might have made the learning task easier. Not having the print words on paper also made learning easier.
3. Tangibility also provided hands-on interaction which provides a third modality – to attract attention and aid memory, and made learning visible.

SLIDE **Limitations**

- **Limitation of our system** is Only looked at six rules and about 76 words. **This limits our ability to generalize our findings and design guidelines to this type of rule and word.**

- **One limitation of study design** -- The within design w/ no control – possible gains are due to learning in class – although these kids had already failed to progress on these 6 rules in class and w/ special instruction in pull-outs. **This limits means we can't be sure our findings are only a result of our intervention (validity). For example,** We can't rule out the impact of Novelty on the children's attention.
- **In addition** Small number of kids | really can't make strong claims w/ inferential stats **This limits our ability to generalize to other children.**

Why this all this matters is because our work **contributes** two things:

We have shown through a proof of concept that tangibility may improve learning outcomes for domains that one may not think of the spatial but that have some mapping to space like language.

Our work also matters because we have enabled children who have failed to learn to read and spell to make significant progress in a relatively short period of time.

Useful We imagine that our findings are useful to other researchers and designers in TC and Education b/c strategies can be used to develop TUIs for

- Other rules of spelling/reading
- Other aspects of language learning w/ dyslexic children
- ESL
- Exemplar of how spatial properties can be mapped to logical properties like the sounds letters make based on position in words.

Future

Address above! And develop a system that uses commercially available hardware …

Questions:

What do you think are the ethical issues of working with vulnerable children? Why did we rule out a controlled experiment?