SynergyNet: Exploring the potential of a multi-touch classroom for teaching and learning

Prof Steve Higgins
School of Education
Durham University
s.e.higgins@durham.ac.uk
The UK’s TLRP – TEL Programme

- Teaching and Learning Research Programme
- Technology Enhanced Learning £12M
- Phase 2: 2008-2012
- One of eight projects

**SynergyNet**: Supporting Collaborative Learning in an Immersive Environment

**HapTEL**: Haptic Technology Enhanced Learning

**Ensemble**: Semantic Technologies for the Enhancement of Case-Based Learning

**MiGen**: Intelligent Support for Mathematical Generalisation

**Inter-Life**: Interoperability and Transition

A **Learning Design Support Environment** (LDSE) for Teachers and Lecturers

**Echoes 2**: Improving Children’s Social Interaction through Exploratory Learning in a Multimodal Environment

**Personal Inquiry** (PI): Designing for Evidence-based Enquiry across Formal and Informal Settings of Learning

http://www.tlrp.org/tel/
The SynergyNet Team

Education & Psychology

John Adams
Joe Elliott
Steve Higgins
Andrew Joyce-Gibbons
Emma Mercier
Richard Remedios
Marina Stíbric

Computer Science

Iyad Alagha
Liz Burd (PI)
Andrew Hatch
Phyo Kyaw
Linxiao Ma
Malcolm Munro
Seamus Smith

Durham University
What are the pedagogical problems multi-touch can solve?

- Multi-touch tables
  - Direct touch, shared control, joint attention
  - Early years – guided interaction, bridging between experiences, plan, do, review; sharing experiences
  - Primary school – embedding effective collaboration and group ‘orchestration’ by teacher
Technology, Teams, Tasks & Teachers
Technology & Teams

- Study 1: multi-touch vs. paper
  - More joint attention with MTT
  - More quickly developed a joint problem space

http://dx.doi.org/10.1111/j.1467-8535.2011.01259.x
Technology & Teams

- Study 2: Room Orientation

- More talk in centered room
- More correct answers in traditional room
- No difference in off-topic talk

Teams & Tasks

- Emergent Roles:
  - Comparison between maths and history mysteries
  - Same groups, technology, task structure
  - Leaders change between tasks
  - More leadership moves during maths than history

Technology & Teachers

Technology, Teams & Tasks

- NumberNet:
  - Within and between group math learning
  - Innovation and practice

Target: 150
100+50
200-50

SynergyNet Classroom

- Multi-touch interactive whiteboard
- Cameras
- ‘Orchestration’ desk
- Microphones
- Multi-touch tables
In use....
Adaptive expertise

- Experts flexibly approach novel problems and can apply a range of solutions (Hatano & Inagaki, 1986)
- Beyond routine expertise (Salomon & Perkins, 1989)
- Or a different form of expertise? (Schwartz, Bransford, & Sears, 2005)
- Flexibility and adaptivity (Verschaffel, Luwen, Torbeyens & Van Dooren, 2009: p 337)
Situated expertise

- The importance of dialogue between learners, which introduces more instances of surprise, perplexity and disco-ordination, and supports students in making links to their own areas of expertise, and those areas in which they are just developing expertise (Hatano, 1988)
Developing adaptive expertise?

NumberNet

‘Make up some questions’ task
Add to each of the other groups’ attempts (3x)
Organise the correct expressions
NumberNet
NumberNet
Teacher control

- From iPad (web interface)
- Timing/rotate tables
- Freeze the action
- Disable keys ‘on the fly’
- Get feedback on correct and incorrect expressions (by group, by individual, by target number)
- Show/hide correct/incorrect expressions
- Show/hide totals (competitive)
- Project tables on the IWB
Feedback to the teacher

<table>
<thead>
<tr>
<th>Table</th>
<th>Person</th>
<th>Expression</th>
<th>Value</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>blue</td>
<td>Ch</td>
<td>20\times3+1</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>red</td>
<td>L</td>
<td>50\times10+1</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>green</td>
<td>Ja</td>
<td>2.63</td>
<td>-61</td>
<td>61</td>
</tr>
<tr>
<td>blue</td>
<td>Be</td>
<td>71-10</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>red</td>
<td>Ca A</td>
<td>70-9</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>red</td>
<td>Ca B</td>
<td>100-41</td>
<td>59</td>
<td>61</td>
</tr>
<tr>
<td>red</td>
<td>Ca A</td>
<td>30+30+1</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>green</td>
<td>P</td>
<td>10+10+10+10+10+10-10</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>yellow</td>
<td>Ro</td>
<td>12\times5+1</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>green</td>
<td>R</td>
<td>31+30</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>green</td>
<td>Ja</td>
<td>61\times1</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>yellow</td>
<td>L</td>
<td>9+60</td>
<td>69</td>
<td>61</td>
</tr>
<tr>
<td>blue</td>
<td>Be</td>
<td>51+10</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>red</td>
<td>Ca A</td>
<td>10+10+10+10+10+10+10-61</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>yellow</td>
<td>Ro</td>
<td>61\times0</td>
<td>0</td>
<td>61</td>
</tr>
<tr>
<td>blue</td>
<td>Jo</td>
<td>20+20+20+1</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>red</td>
<td>Br</td>
<td>63-2</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>green</td>
<td>Ma</td>
<td>1+30+30</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>green</td>
<td>Ry</td>
<td>30+31</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>red</td>
<td>Br</td>
<td>62-1</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>red</td>
<td>Ca B</td>
<td>80+1</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>red</td>
<td>Br</td>
<td>50+11</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>blue</td>
<td>Be</td>
<td>40+21</td>
<td>61</td>
<td>61</td>
</tr>
<tr>
<td>blue</td>
<td>Charlie</td>
<td>100-39</td>
<td>61</td>
<td>61</td>
</tr>
</tbody>
</table>

Correct: 19
Incorrect: 5
NumberNet: making connections
NumberNet Study 1

- Matched groups experimental design (N=86)
- Same time on number tasks in both conditions (NumberNet or Classroom)
- Used most simple version of NumberNet
- Paper-based pre/post test (dependent measures):
  - Number of correct calculations
  - Number of unique strings
  - Maximum operators in a single calculation
Number of Correct Calculations

F(1, 84) = 31.01 p <.001, η² = .27
Maximum operators in a single calculation

$F(1, 84) = 2.036, \ p = .157, \ \eta^2 = .024,$
Unique strings

Number of Unique Strings

F(1, 84) = .186, p = .667, η² = .002
Experimental analysis

Both groups improved in terms of number correct

Effect of time **significant** for correct calculations, $F(1, 84) = 31.01, p < .001, \eta^2 = .27$ and maximum number of operators in a calculation, $F(1, 84) = 4.469, p = .037, \eta^2 = .051$. Not significant for unique strings, $F(1, 84) = .858, p = .357, \eta^2 = .01$.

Time by condition interaction was **not significant** for correct calculations, $F(1, 84) = .186, p = .667, \eta^2 = .002$ nor for maximum number of operators in a single calculation, $F(1, 84) = 2.036, p = .157, \eta^2 = .024$.

**NumberNet activity developed more creative solutions – adaptive expertise?**

Time by condition effect was significant for number of unique strings, $F(1, 84) = 11.63, p = .001, \eta^2 = .122$, ES 0.74: Lipsey and Wilson, 2001: p 207.
Exploratory video analysis

- Case studies of one group’s interaction to gain an understanding of whether using NumberNet has any effect on the students’ mathematical flexibility when compared with practice on the more traditional activity
Interaction analysis

- Groups learn from other group members (e.g., agreeing not to duplicate and suggesting corrections)
- Groups learn from other groups (using ideas)
- Groups learn from identifying patterns in solutions (their own and others)
Initial group strategy & competition
(1.42-2.00)

Chelsea: is any of you doing 30 add 31?
Adam: I'm doing all the take aways!
Jack: I'm doing take aways as well
Chelsea: I'll do add
Adam: I'm doing take aways
Jack: Ahh Adam, I've done 100 take away 39, beat that!
Between group learning
Jack: Who done... Who's green? Jiminy... That's quite smart! [the calculations have a colour border indicating the table where they were created, so Jack is asking which is the green table, and so who was responsible for the calculation]

Adam: Oh look at that! 10 times 10 that equals 100, add 50! Now that's clever, whoever did that! I'm doing that...
Once the teacher turns on the number pads, Jack goes on to adapt the calculations he has seen, creating the calculations $10\times10+51-1$, and drawing Adam’s attention to it:

Jack: Haha! Adam, look at the size of that!
Adam: Oh yes, did it... 1... 5...
Jack: ‘Cause 10 times 10 is 100, add 51 is 151 and take away 1 is 150... bingo!
Adam: Bingo!
Group competition and correction

Chelsea: Yes!! [*arms raised in triumph*]
Jack: You’ve done a big one as well?
Jack: [*after looking at Chelsea’s calculation*] That's wrong! It's 150, not 151! You've done add 1, delete it. We’re going to get one wrong! Delete it! Cancel it!
Teacher: Right, I'm going to stop you again.
[Chelsea pulls the calculation back onto her number pad, deleting the +1 and trying to send it back to the table, as Jack and Adam cheer her on]
Jack: Hurry, hurry! Go on, quickly!
Adam: Yes! Get in! Last second!
Connecting ideas and finding patterns
Finding patterns
(15:20)
Conclusions

- Both conditions support routine expertise
- NumberNet allows within and between group learning
- NumberNet appears to support adaptive expertise
  - Flexibility supported by the task design
  - Adaptivity by pupils’ understanding of the goals
SynergyNet: what we’ve learned:

- Multi-touch supports joint attention and collaborative interaction (joint control)
- Teacher intervention at whole-class level
  - Leads groups to move to a higher level of reasoning (SOLO)
- Teacher orchestration
  - Teachers like to be able to manage the student tables, and project the student tables to the IWB
    - Dislike having to use table at front of room
    - Dislike having to carry iPad
    - Experimented with Kinect motion sensor.
Summary

- Multi-touch supports joint attention
- Room orientation changes interaction
- Content area influences emergent roles
- Access to teacher controls an issue
- We can support Within and Between Group Learning
- Teacher intervention and whole class influence on learning
The questions we’re still asking:

- How does whole-class discussion influence the reasoning of the group?
  - Uptake of new ideas?
  - Students read signals that they need to progress?
  - Support for uptake of ideas between groups?
- What sort of tasks take advantage of the between-group interaction?
Relational understanding of CSCL
You Tube demonstrations

http://www.youtube.com/watch?v=G4BhQtcjE3g&list=PL3A2C3D35C1883FD4
SynergyNet’s publications

Journal articles
Mercier, E., Higgins, S. and Da Costa. L (Being revised) "Different Leaders: Emergent Organizational and Intellectual Leadership in Children's Collaborative Learning Groups" International Journal of Computer Supported Collaborative Learning

Published Conference papers