Teachers and Researchers Talk About Classroom Connectivity

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Democratizing Access

- Mathematical alienation
- Motivation repressed via opaque classroom objectives
- Curriculum restrictions
- Classroom participation is an expectation rather than a phenomenological artifact of productive learning
SimCalc MathWorlds

- Dynamic interactive representations that are linked, e.g. edit a position function and automatically see velocity graphs update
- Graphically and algebraically editable functions
- Import motion data and re-animate (CBR & CBL2)
- Simulations are at the heart of SimCalc - executable representations (Moreno, 2001)
SimCalc MathWorlds - The Product

- The historic evolutions of two software into one integrated product
- SMW for the TI 83+/84+ - Version 6.0
- SMW for the Desktop PC (cross-platform for non-connected work) - Version 4.0
- Mental Model for users: Microsoft Office - Can be used in integrated ways or independently - documents can be written to be used in other applications
SimCalc “Connected” MathWorlds

- TI-Navigator Network
- New generation of SimCalc that increases participation, motivation and learning
- Exploits wireless networks to allow the aggregation of student work in mathematically meaningful ways
- Teachers have powerful classroom management tools to focus attention and pedagogical agenda
- Student work becomes contextualized into a class of contributions for comparison and generalization
- Mathematical thinking goes from a local to a social activity
Three fundamental powers of connectivity

- *To harvest* students work to examine variation and common misconceptions (error analysis)
- *To aggregate* students work in a mathematically meaningful way – use natural variation to examine parametric variation (i.e. each student varies a parameter)
- *To focus on connections across representations*, i.e. students work with representation A (e.g. a velocity graph) and the teacher displays/works with representation B (e.g. a position graph) - cf. Kaput 1991
Parallel Software

Executable Representations

From Student Device

To Teacher Display
SimCalc in action!

Let’s demonstrate an activity!
Dynamic Mathematics

• Dynamic representations are a new access route to new visions of mathematical ideas and problem solving

• Connectivity is a foundation to allow public collaboration, mutual expression in dynamic media, physical expression through time and space via gesture, discourse and action, and social cognition.
Classroom Management: a fundamental design principle in a representationally-rich environment

- Collecting/Receiving – allows two forms of agency in the classroom/distributed agency
- Post-Connectivity: Data management vs Representational management - role of filters to assess students’ progressive understanding (i.e. representational timestamps) and systematically generate public reasoning and generalization
- Note: This is not always about allowing students to have ownership of the public display space - we tightly control this
- Design challenges and solution strategies - roster as a central ordering principle
Exploiting Connectivity

• Facilitate work-flow,
• Aggregate student constructions to: i. vary essential parameters on a per-student basis, ii. elevate student attention from single objects to parameterized families of objects,
• Provide opportunity for generalization and expose common thought-patterns (e.g. errors)
• Students make personally meaningful mathematical objects to be publicly shared and discussed
• Students project their personal identity into the objects and constructed motions
• Students math and social experience are deeply intertwined
• Teachers are in a central role to orchestrate whole class of events
Some Top-Level Thoughts

- Students experience and contributions are embedded in a social workspace.
- Mathematical structure and understanding can be emergent, e.g. What do you expect to see before I show you the ...
- Representational infrastructure includes data management systems to manage the flow of information and examination of mathematical sub-structures; such power serves a variety of pedagogical needs, and sustains pedagogical flexibility.
Impact on Learning
Connectivity Study

All 9th grade High School Algebra 1 students in two districts took a pre- and post-test. A selection of teachers in these schools participated in a SimCalc Intervention in which they temporarily replaced part of their regular curriculum with SimCalc materials for 3-6 weeks.

The bar graph to the left illustrates the mean gains from pre to post for the Comparison versus Treatment groups. In the Treatment group the mean gain is about 2 points out of a total of 26 points. In the Comparison group the mean gain is about 1 point. This group difference is statistically significant, $t=2.465$ ($p<0.015$).

Along with Pre-post data, we have video data (to develop student case studies), attitude survey data, student and teacher interviews.
Conclusions

• Research-to-date shows positive impact on mathematical knowledge (necessary and advanced) AND participation and motivation to do mathematics (attitude & behavioral data)

• Over 6 years of design & experimentation has produced a software environment that redefines the educational landscape of the mathematics classroom in the 21st century

• Dynamic Representations and in-class communication infrastructure + mathematically meaningful activities = powerful opportunities for MORE students.
Other Sessions

• For more info go to TI booth - ask about SimCalc Activities

• Software

• Establishment of the Kaput Center

• 944. Exponential Motion! James Burke, Derek Beaton