

Toward Haptic/Aural Touchscreen Display of Graphical Mathematics for the Education of Blind Students

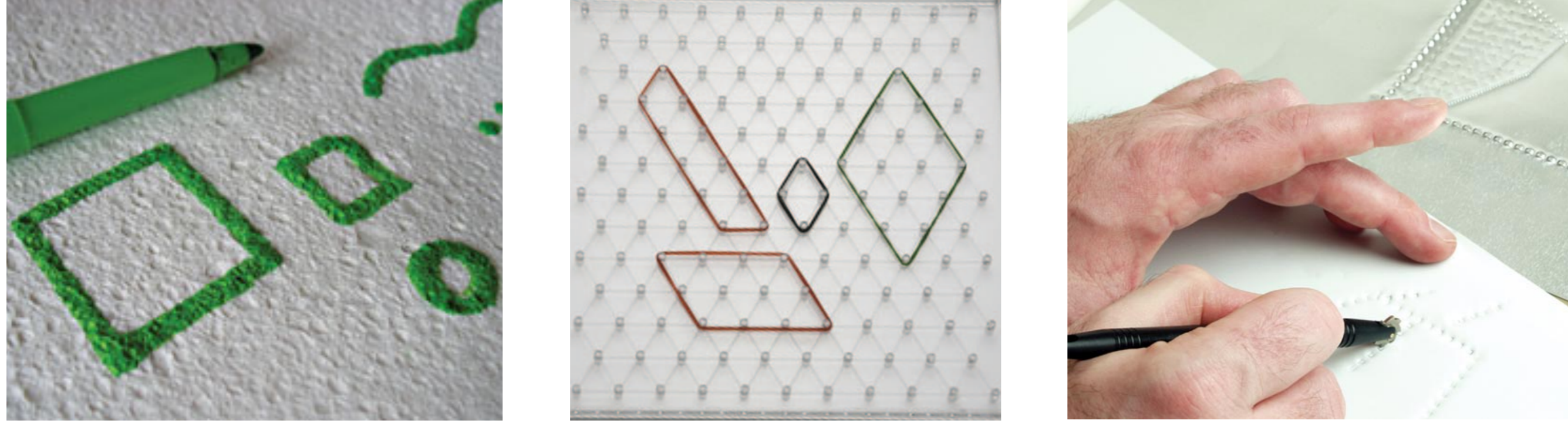


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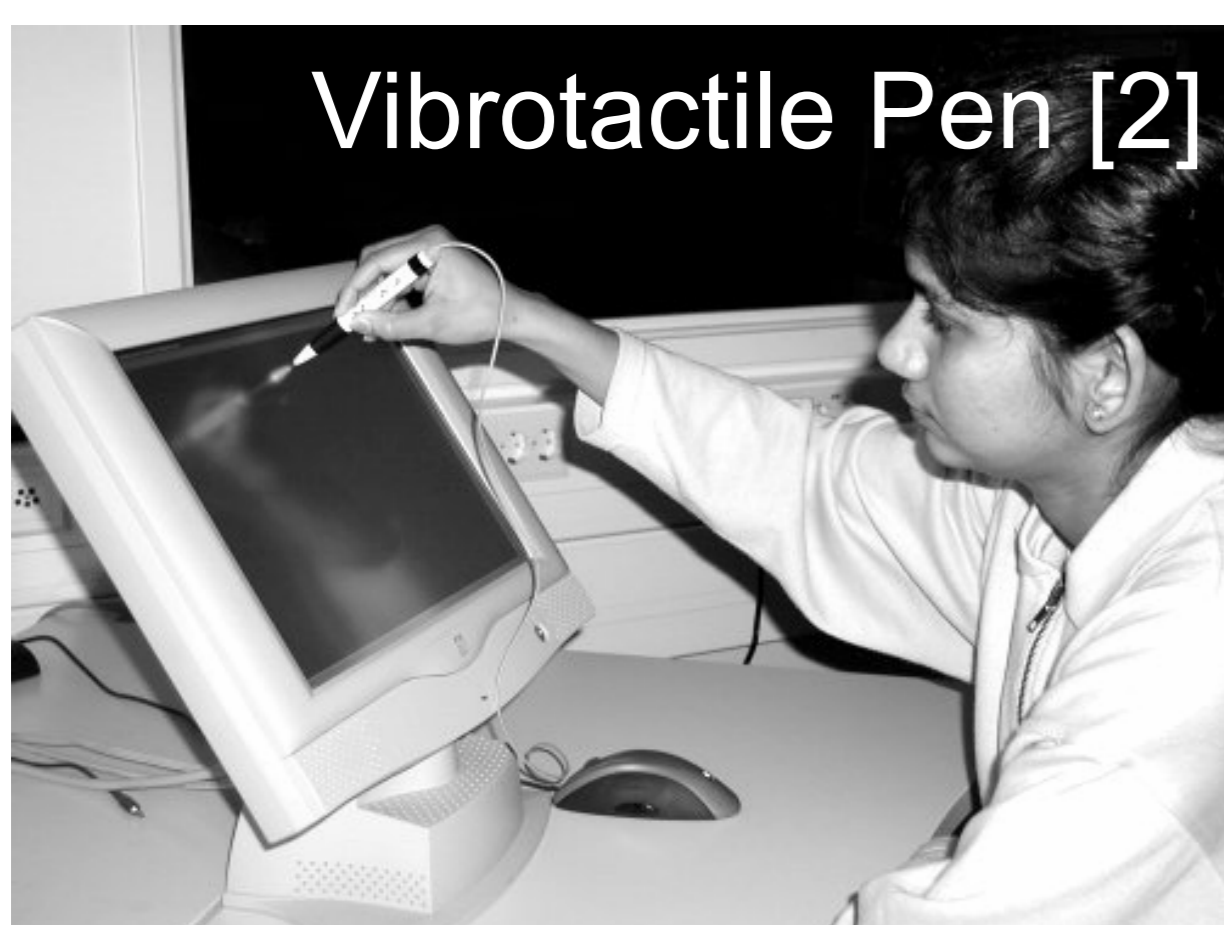


Motivation

- Blind students see math through touch.



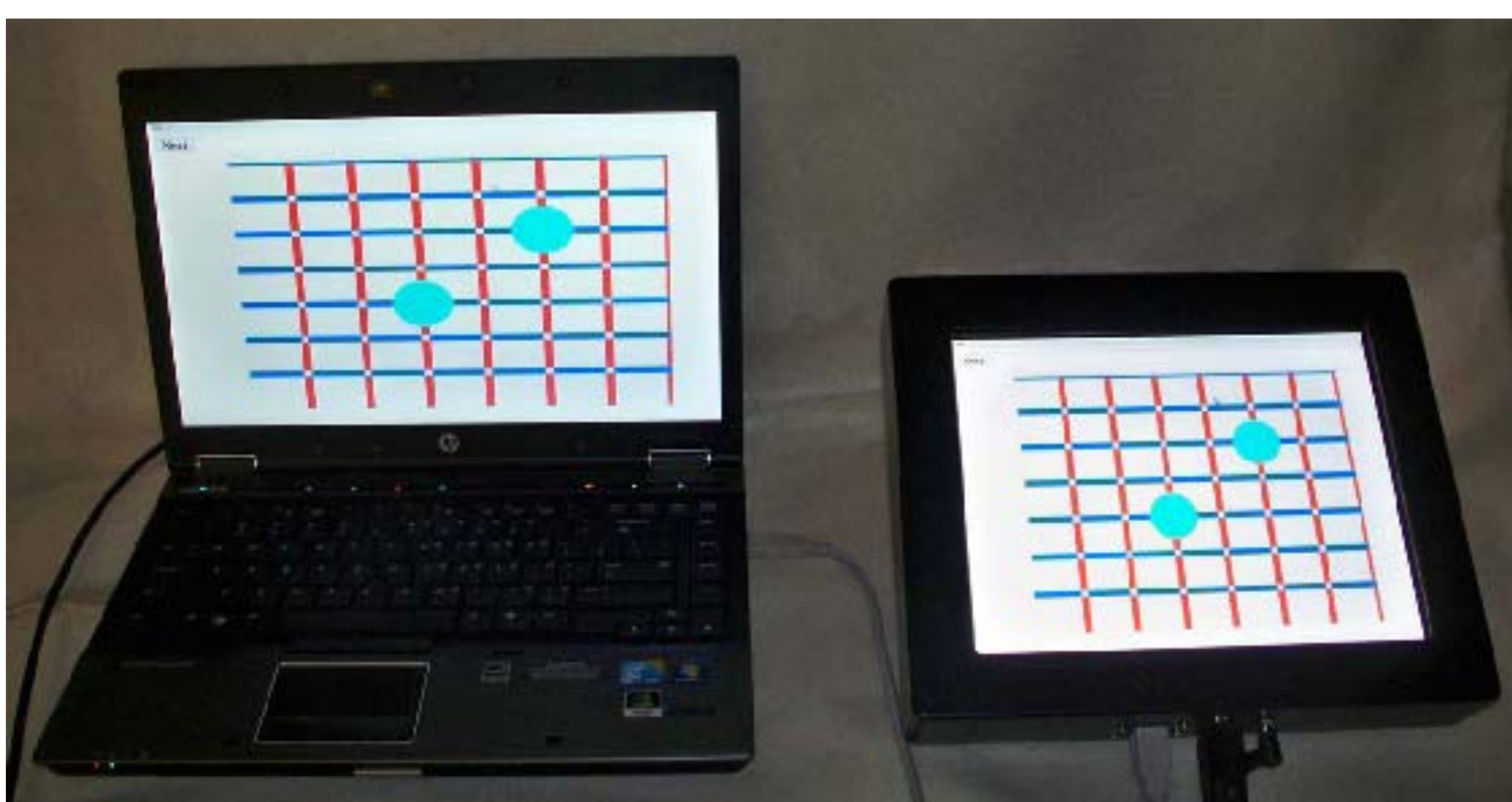
- Haptic devices can increase the flexibility and richness of information display.



- We desire a simpler, lower-cost device that enables lessons analogous to those used in regular classrooms.

Approach: Haptic Touchscreen

- Direct user interaction
- Easy classroom integration
- Potential to teach multiple students



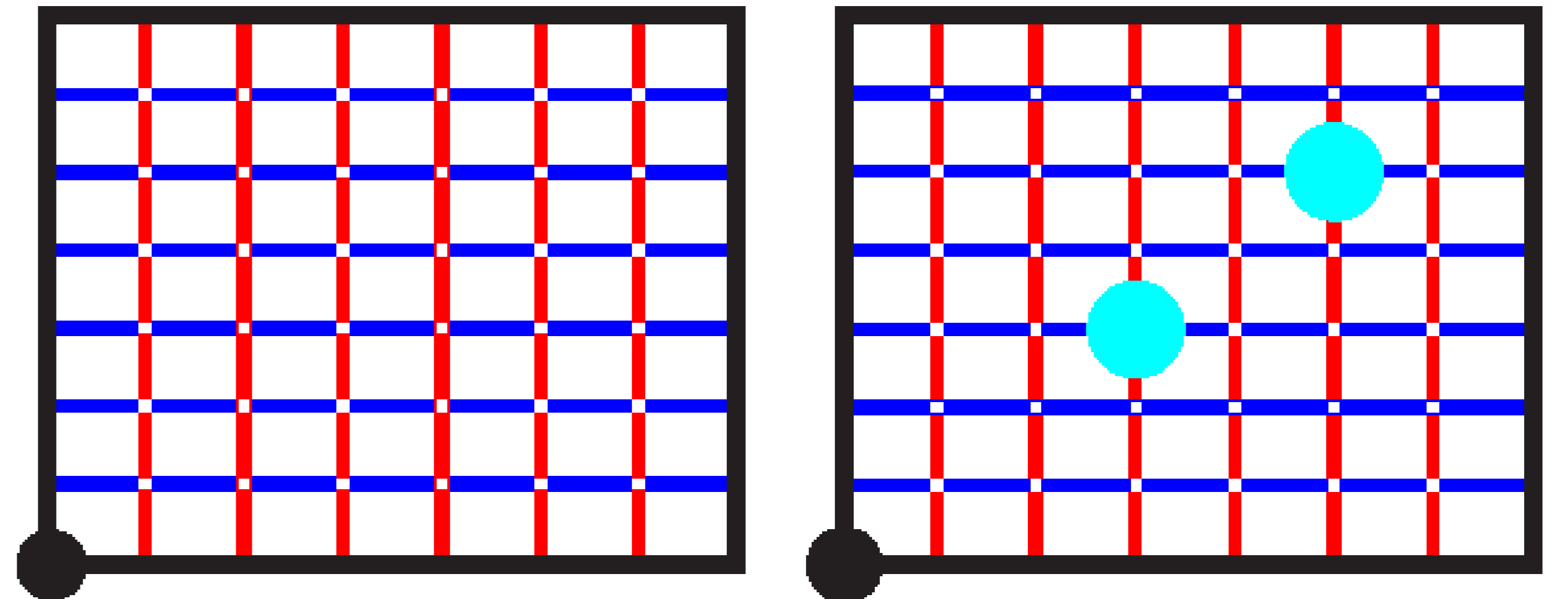
Graphical Math in K-12 Education

- Kindergarten: Children introduced to shapes and lines [4]
- 6th Grade: Cartesian coordinates, points, slope [4]
- High school: Trigonometry, Calculus, etc.

Feasibility Study

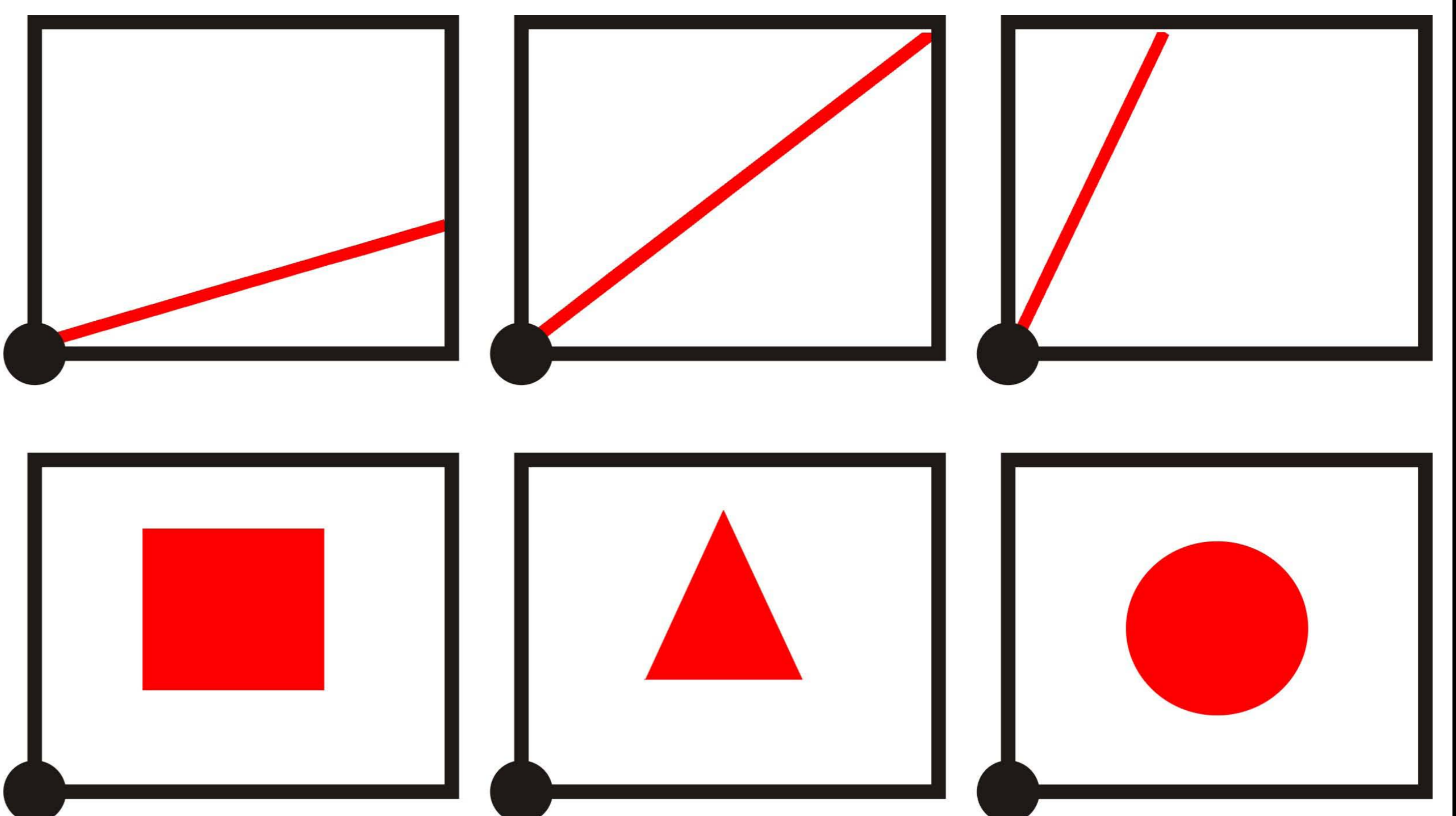
- Can users “see” a grid? Can they find points on it?
- Can users “see” shapes and slopes?
- Is Haptic or Auditory feedback (or a mix) preferable?

Point/Coordinate Experiment



- Users found 100% of displayed points.
- Correct point locations identified 87.5% of the time (no statistically significant difference for any haptic/aural case.)
- Users found a verbally specified grid intersection correctly 66% of the time. (No significant haptic/aural difference).

Shape & Line Experiment



- 98% correct identification of lines
- 68% correct identification of shapes
- Users better at identifying lines than shapes ($p < 0.02$)
- No significant haptic vs. aural differences

Future Work

- Develop touchscreen-based math lessons with teachers
- Evaluate learning outcomes compared to control groups taught the same concepts using traditional methods
- Psychophysical experiments with blind subjects
- Math lessons with blind children

References

- [1] Ramloll, Constructing Sonified Haptic Line Graphs for the Blind Student. ACM Conference on Assistive Technologies, ASSETS, 2000.
- [2] Sharmin, Non-visual feedback cues for pen computing. World Haptics, 2005.
- [3] Watanabe, Practical use of interactive tactile graphic display system at a school for the blind. Current Developments in Technology-Assisted Education, p. 1111–1115, 2006.
- [4] Tennessee Department of Education Curriculum Standards. <http://www.tennessee.gov/education/ci/math/index.shtml>.