





#### Who is eGrove Education, Inc.?

- Start-up out of UC San Diego
- We make STEM teachers more effective and their students
- more successful
- Touchscreen based sketching app with personalized feedback to support STEM education

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# Importance of Spatial Visualization and Sketching in STEM

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# The Importance of Sketching

- Improves SV skills [Sorby, 2009]
- Used in concept generation and creativity [Gross 1986]
- Used in teamwork for communication
- Is sometimes undervalued relative to computer aided design

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Individual Students with Low Pre-Test Categorized into Two Groups	Pre-Test Score	Post-Test Score	Test Improvemen
Low Pre-Test: No/Low Improvement	53%	57%	6%
Low Pre-Test: No/Low Improvement	53%	57%	6%
Low Pre-Test: No/Low Improvement	63%	63%	0%
Low Pre-Test: No/Low Improvement	40%	40%	0%
Low Pre-Test: No/Low Improvement	67%	63%	-5%
Low Pre-Test: No/Low Improvement	53%	43%	-19%
Low Pre-Test: No/Low Improvement	67%	57%	-15%
Average (n=7)	57% σ=9.6%	54% σ=9.2%	<mark>-4%</mark> σ=9.8%
Low Pre-Test: With Significant Improvement	57%	90%	59%
Low Pre-Test: With Significant Improvement	53%	73%	38%
Low Pre-Test: With Significant Improvement	47%	67%	43%
Low Pre-Test: With Significant Improvement	40%	57%	42%
Low Pre-Test: With Significant Improvement	57%	73%	29%
Low Pre-Test: With Significant Improvement	37%	53%	45%
Average (n=6)	48% σ=8.6%	69% σ=13.3%	43% σ=9.7%

#### **Predictor of Success: Persistence**

Performance Metrics	Low Pre-Test: With Significant Improvement (n=6)	Low Pre- Test: No/Low Improvement (n=7)	Percentage Difference
Percentage of Assignments Attempted	94% σ=1.4%	95% σ=1.9%	-1%
Percentage Correct on 1st Attempt (no peeking)	46% σ=13.9%	23% σ=11.1%	50%
Percentage Eventually Correct Without Peeking	55% σ=13.6%	28% σ=13.5%	48%
Percentage Eventually Correct Including Peeking	92% σ=1.8%	83% σ=9.5%	10%
Percentage Tried Again Without Peeking	27% σ=18.8%	7% σ=6.6%	74%
Multiple Choice Questions Attempted	260 σ=0.0	260 σ=0.5	0%
Percentage of Multiple Choice Questions Correct	73% g=6.9%	63% σ=8.7%	14%

Challenge: How can we increase persistence?





Yes! Increase	Low Pre-Test Student (PSVT:R <= 70%)		
Year/ Class	Avg Pre-Test Score	Avg Post-Test Score	Students that moved out of Low Group (Post-Test above 70%)
MAE7 2014 (n=13) elective	55%	64%	23%
MAE7 2016 (n=10) elective	53%	61%	40%
MAE7 2017 (n=11) elective	61%	80%	82%
SE3 2017 (n=27) required	57%	75%	67%
SE3 2018* (n=41) required	57% Percent Tried	76%	85%
Persistence Data MAE7 2014 Lo SE2 2017 Low	Percent Tried w Pre-Test St Pro Tost Stur	LAgain Witho tudents: 16%	Lit Peeking



# Spatial Vis Engineering<sup>™</sup> App

- Sketching on touchscreens
- Automatic grading providing instantaneous feedback to students
- Personalized hints as if teacher looking over shoulder of student
- Gamification to increase engagement and encourage persistence
- Allows students to complete SV assignments in classroom or at home.
- Data analytics for teacher.

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interface and first few assignments in 2D rotations







# Mini Hints

- Small hints that are provided when a student gets a sketch wrong.
- Provided without point penalty
- Based upon what the student drew
- But, the do NOT show students specific lines in the sketch that are correct or incorrect.
- They leave it up to the student to find the error areas.





















### Survey Results: Overall impression of app

**Leaving Thoughts** 



95.2% said they would

recommend the app to others with low SV skills

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#### Free Teacher Account Available for Participants

If you want grading for all assignments, please see me for instructions and the access code for a free teacher account.

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- Spatial Vis<sup>™</sup> App has evolved based on experiences in the classroom
- Can measure AND increase persistence
- Currently working to keep students in the ZPD with mini hints
- Development of elementary math app underway to teach fractions through sketching (Drawn2Math)





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 Nathan Delson and Lelli Van Den Einde have an equity interest in eGrove Education, Inc., a company that may potentially benefit from these research results. The terms of this arrangement have been reviewed and approved by the University of California, San Diego in accordance with its conflict of interest policies

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#### **THANK YOU!**

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