

A Scalable Online Platform for Evaluating and Training Engineering Students' Visuospatial Skills

Ziang Xiao

Sanorita Dey

James M. Leake

Yuqi Yao

Helen Wauck

Brain S. Woodard

Eric Chi-Hsien Yen

Angela Wolters

Wai-Tat Fu

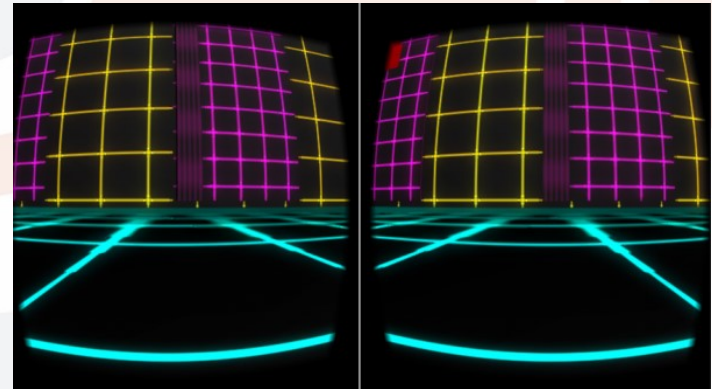
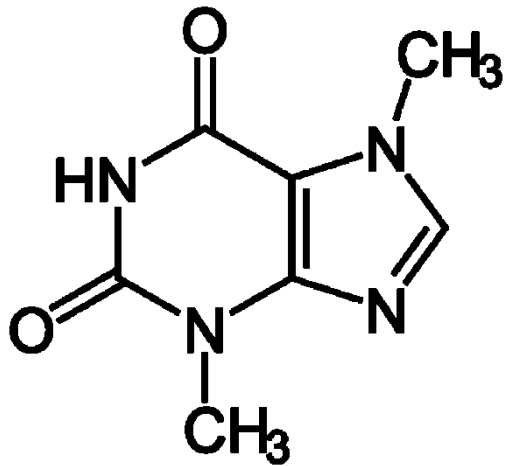


University of Illinois at Urbana-Champaign

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Intro

Visuospatial skill the capacity to understand, reason and remember the spatial relations among objects or space.



Intro

Students' visuospatial skills are important for

- Learning
- Future performance
- Retention rates
- Career choices

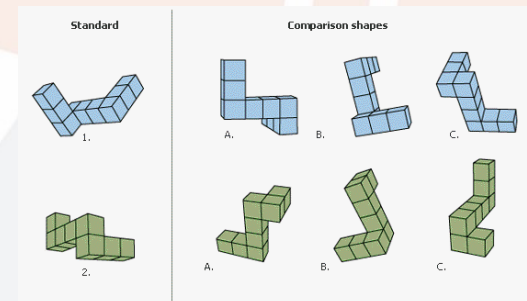
in the STEM field.



(Lubinski,2010; Veurink, and Hamlin,2011;Veurink, & Sorby, 2012)

Intro

Researchers and instructors have put a lot of effort into evaluating and training students' visuospatial skills.

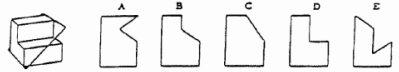
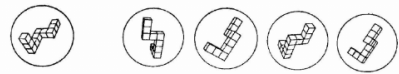
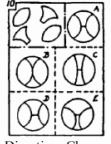
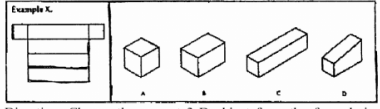
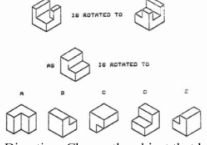


However

Previous methods often rely on

- Traditional paper-based evaluation method
- Face-to-face workshop

which are **time-consuming** and **costly** especially for **large** classes.

Spatial test	Sample item
Mental Cutting Test [21]	 <p>Direction: Choose the resulting cross-section from the cut of the 3-D object.</p>
Mental Rotations Test [22]	 <p>Direction: Choose the two figures that are identical to the one on the far left.</p>
Revised Minnesota Paper Form Board Test [23]	 <p>Direction: Choose the figure that displays the pieces joined together.</p>
Differential Aptitude Test: Spatial Relation [24]	<p>Example X.</p>  <p>Direction: Choose the correct 3-D object from the four choices that would result from folding the given 2-D pattern.</p>
Purdue Spatial Visualization Tests: Visualization of Rotations [27]	 <p>Direction: Choose the object that has the same rotation as shown in the top line.</p>

Online Platform

Our online platform is designed to offer

- a comprehensive assessment of visuospatial skills with multiple choice questions and free-hand sketching
- exercises that help students to acquire strategies to more effectively perform visuospatial problem-solving

on a **large** scale.

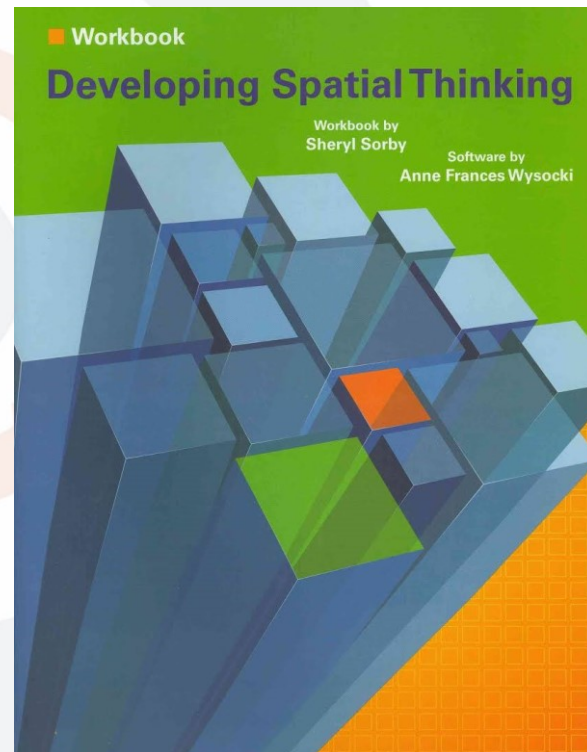
Features



- Automatic grading
 - Intermediate Feedback
- Data management
 - Nation-wide database
- Fine-grained behavior data collection
 - Student's problem solving strategy
- Student's performance tracking
 - Individualized learning

Workshop

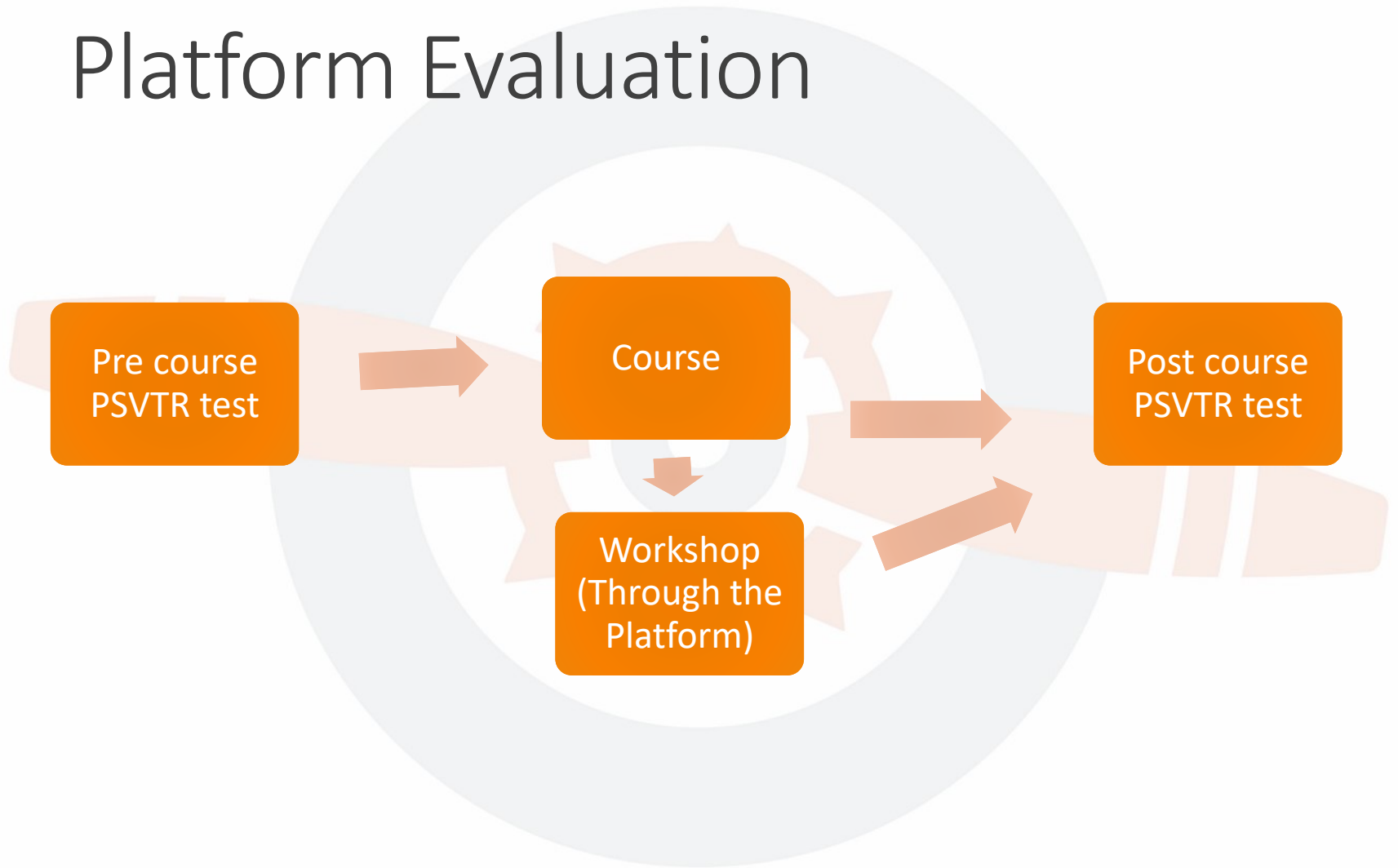
The content of the online workshop was adopted Sorby's (2011) "Developing Spatial Thinking".



Platform Demo

Demo

Platform Evaluation

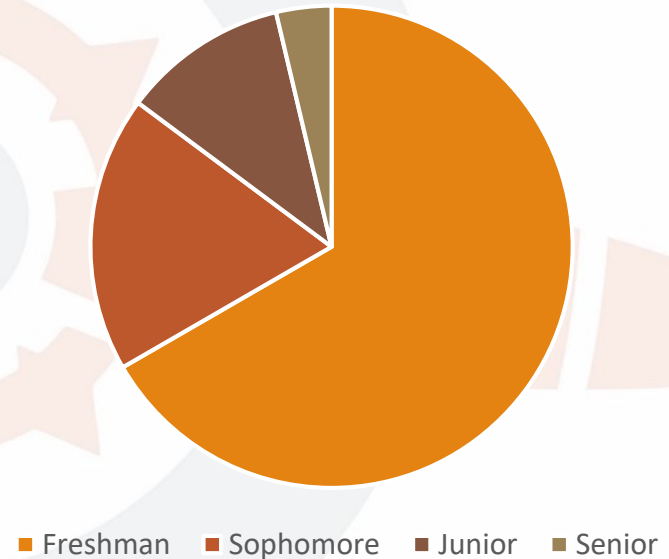


Participants

Pre-test Participants

Total of **624** students from **AE199 (Computer-Aided Design)**, **GE101 (Engineering Graphics & Design)**, **TAM 210 (Intro to Statics)** and **TAM 211 (Statics)** used our platform to conduct the PSVTR test at the beginning of the semester.

Class Standing

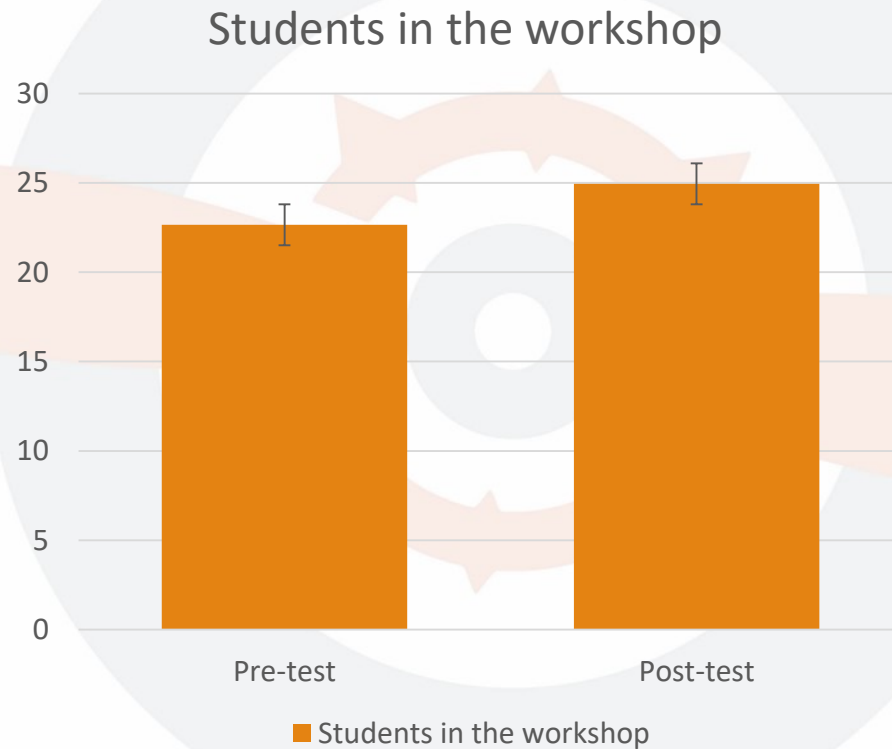


Workshop Participants

The background of the slide features a large, light blue gear. Overlaid on this is a smaller, orange gear with a hand holding a pencil, positioned as if drawing or pointing at the gear. The hand and pencil are also orange. The entire graphic is centered on the slide.

We recruited 30 students (PSVT:R score $M=21.3$) from GE101 and AE199 to participate our workshop. Total of 17 students completed all the tasks.

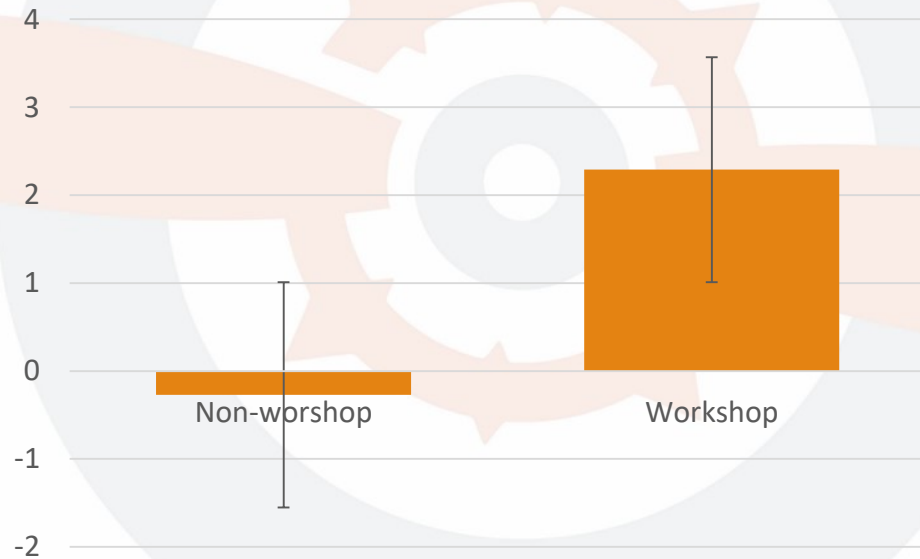
Result



$t = 2.35, p = .03.$

Result

Comparison of improvement
between students in the workshop
and students not in the workshop

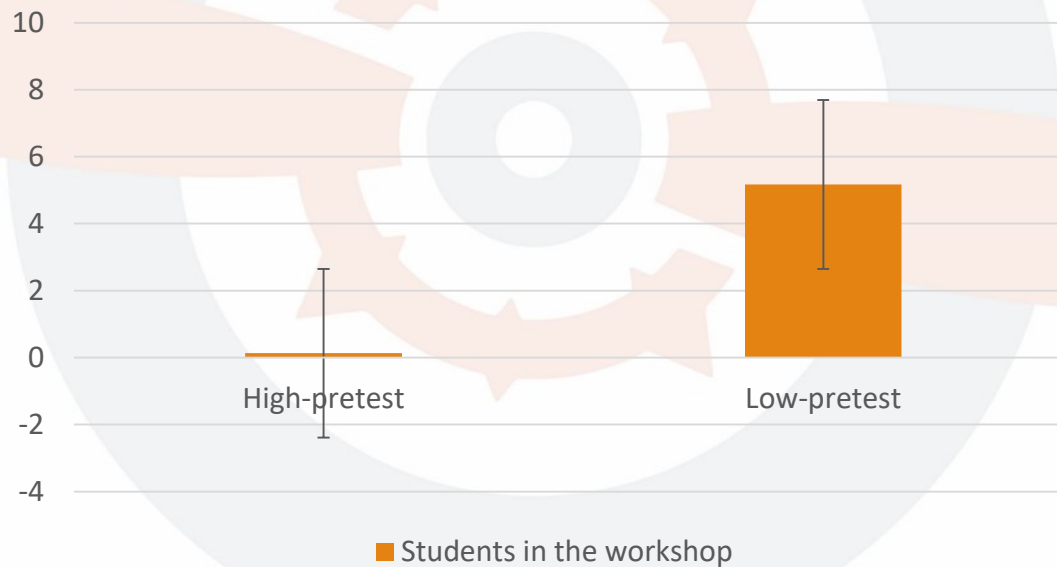


■ Students in the class

$t = 2.418, p = .02.$

Result

Comparison of improvement between students with low pre-test score and students with high pre-test score



$t = -2.017, p = .08.$

Interview Result



Students normally spent 38 min on the exercise each week.

88% Students like the flexibility of the online platform.

- They often took the task after 7:00 pm or during the weekend.

Conclusion

The preliminary study shows that online platform can effectively evaluate the visuospatial skills in a large scale and train the visuospatial skills with very low cost.

Future plan

The background features a large, light blue gear centered behind the text. Overlaid on this is a smaller, orange gear with four arrows pointing outwards, suggesting a cycle or process. A light orange pencil is positioned horizontally across the middle of the slide, with its tip pointing to the right. The pencil has two white rings near the eraser and the lead tip.

- Automatic grading on free-hand sketching problems
- Error pattern analysis
- Individualized hints / training
- Apply to a larger scale (e.g. incoming freshman)

Acknowledgement



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for funding this project

Instructors and Teaching Assistants from GE101 and AE199

for encouraging students to participate our study