



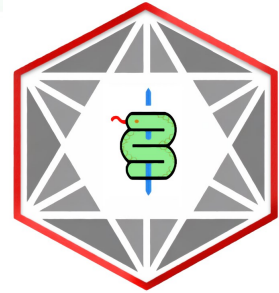
The 8th International  
**STEM Education  
Conference 2023**

# Visual Perceptual Ability and Academic Achievement in Undergraduate Engineering



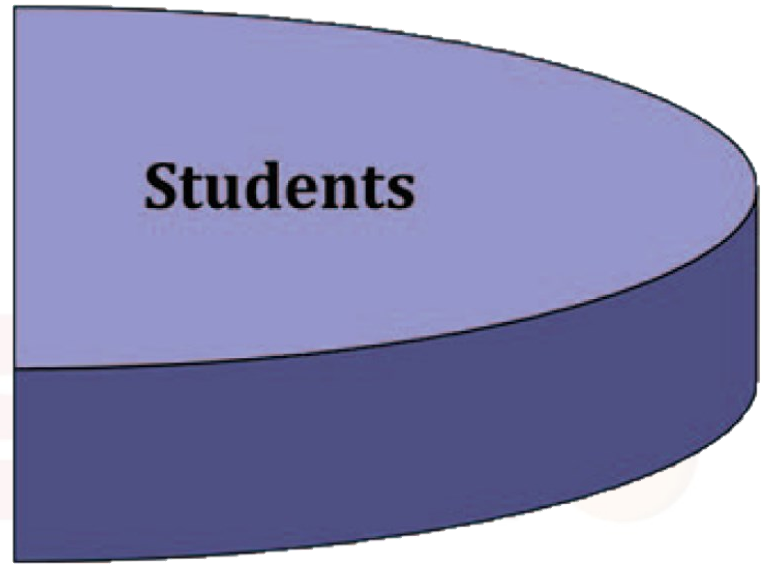
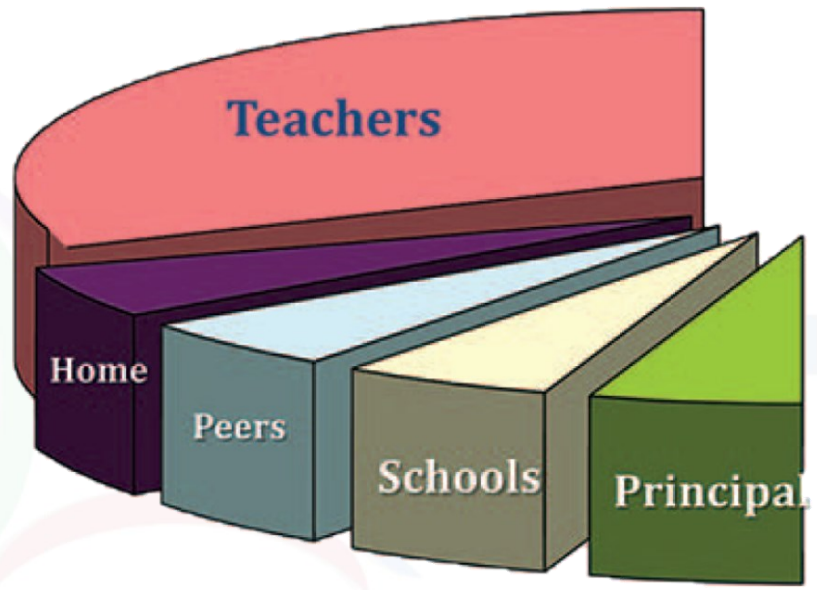
**Chula**  
Chulalongkorn University

Dr Graham Pluck



**CLINICAL  
COGNITIVE  
SCIENCES  
LAB**





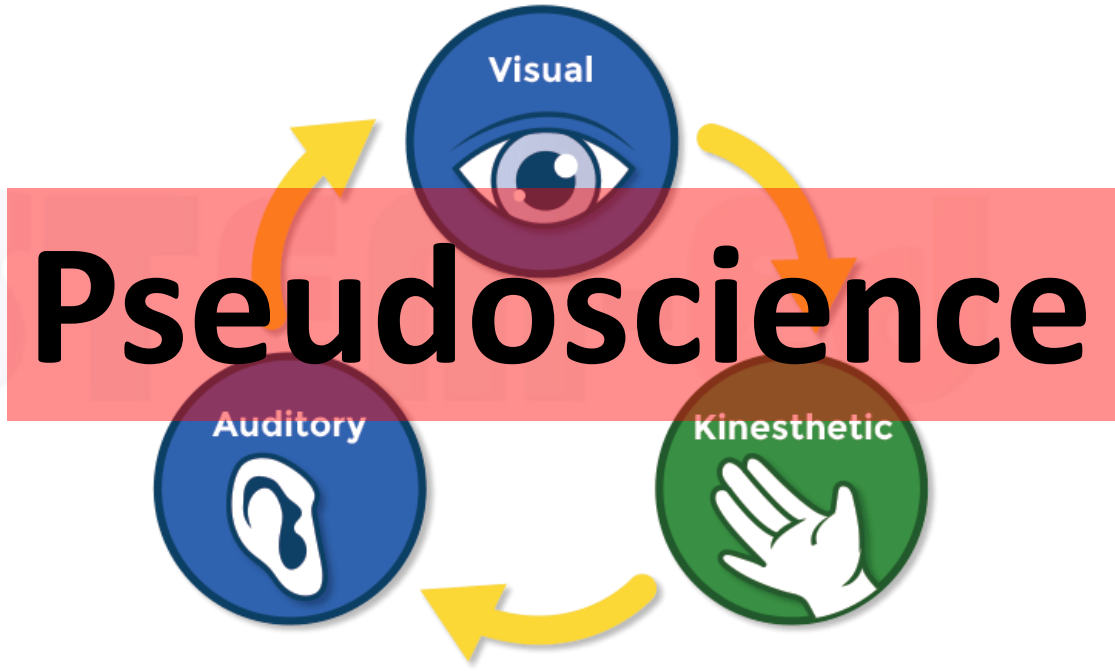
A huge analysis of studies of achievement in higher education suggests that about 50% of variance in grades is due to student disposition.

J. Hattie, "The applicability of Visible Learning to higher education," *Scholarsh. Teach. Learn. Psychol.*, vol. 1, pp. 709–91, 2015.



- Many educators realise this.
- But unfortunately choose approaches that are not scientifically supported.

## Three Main Pathways to the Brain



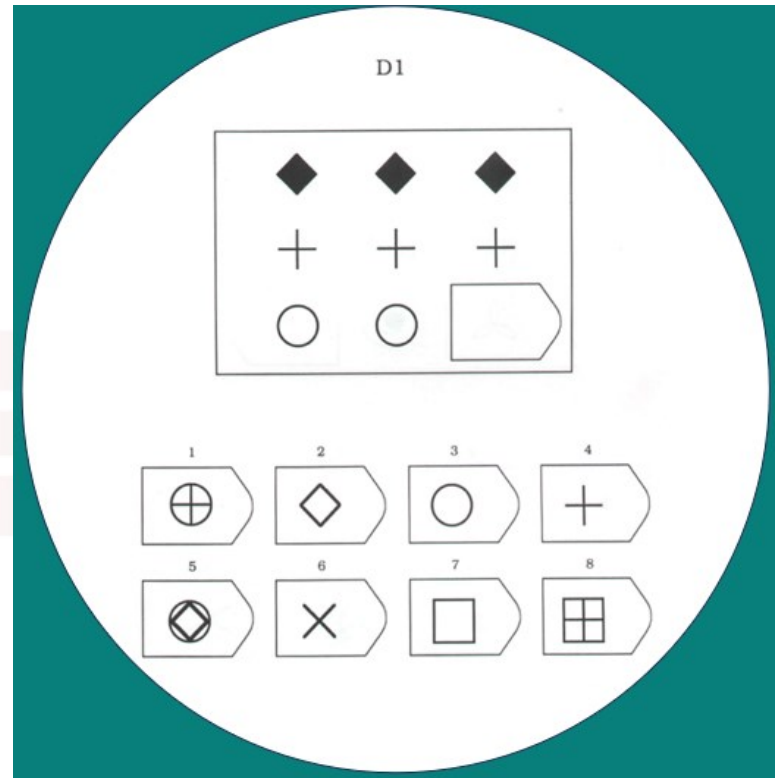
B. Hood, P. Howard-Jones, D. Laurillard, D. Bishop, F. Coffield, U. Frith, "No evidence to back idea of learning styles," The Guardian, 12 March, 2017.



IQ tests have a long history of educational use.

Intelligence is a real thing.

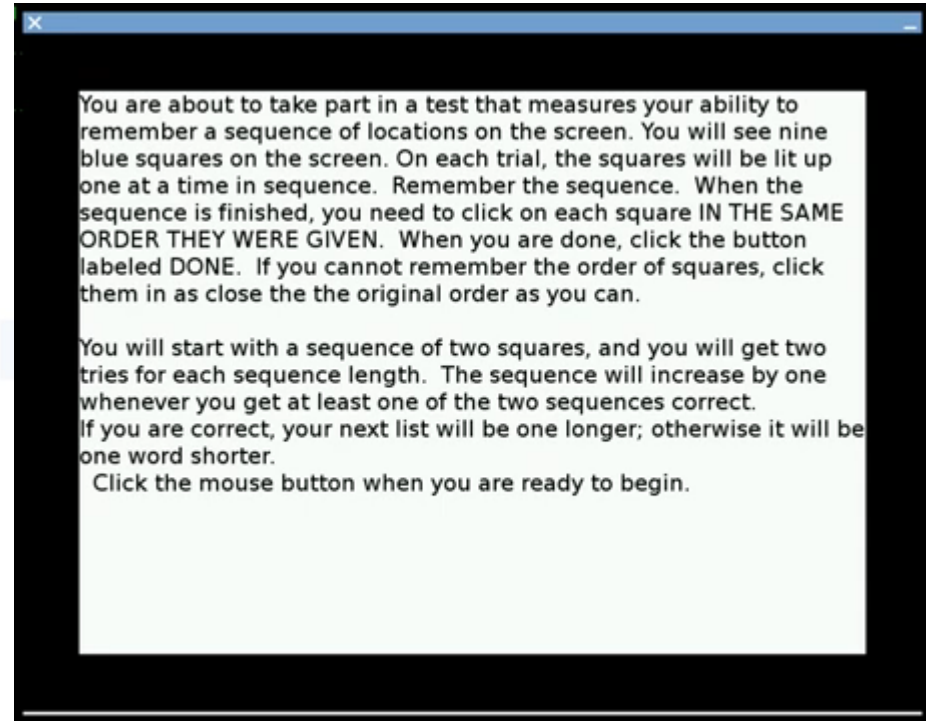
Fluid intelligence in particular, is the kind of 'online' reasoning



M. Richardson, C. Abraham, and R. Bond, "Psychological correlates of university students' academic performance: a systematic review and meta-analysis," Psychol. Bull., vol. 138, No. 2, pp. 353-387, 2012.



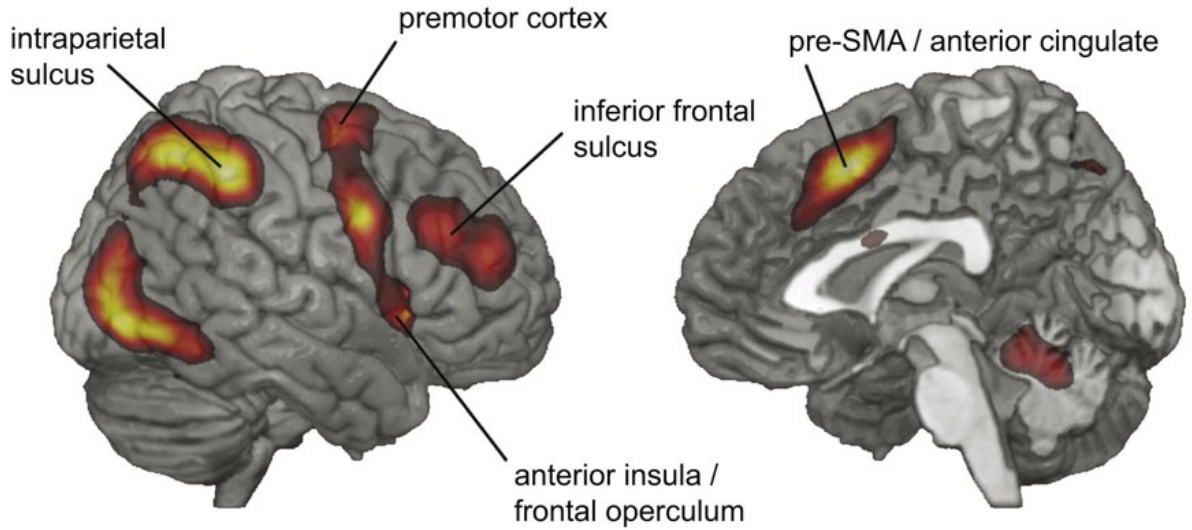
‘Working memory’  
is also an important  
approach.  
It does predict  
achievement in  
math-intensive  
STEM courses.



M. Berkowitz, P. Edelsbrunner, and E. Stern, “The relation between working memory and mathematics performance among students in math-intensive STEM programs” *Intelligence*, vol. 92, 101649, 2022.



- Fluid intelligence involves a *domain-general* system in the brain.
- The ‘multiple demand system’.
- This includes working memory ability and IQ tests.



J. Duncan, "The multiple-demand (MD) system of the primate brain: mental programs for intelligent behaviour". Trends Cogn. Sci., vol. 14, No. 4, pp. 172-179, 2010.



# The 8th International STEM Education Conference 2023

	Maths	Science	English Lit	English Lang	Religion	Language	Overall
WPT 'IQ'	0.46** (0.50)	0.34** (0.33)	0.22 (0.24)	0.22 (0.30)	0.17 (0.15)	0.14 (0.15)	0.34** (0.37)

Although IQ predicts grades of adolescent students, it does so mainly for STEM subjects, not non-STEM subjects

Furnham, A., Rinaldelli-Tabaton, E., & Chamorro-Premuzic, T. (2011). Personality and intelligence predict arts and science school results in 16 year olds. *Psychologia*, 54(1), 39-51.





# The 8th International STEM Education Conference 2023

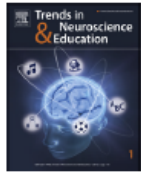
- At University intelligence does predict achievement of engineering students.
- But not of social science students.



Contents lists available at [ScienceDirect](#)

## Trends in Neuroscience and Education

journal homepage: [www.elsevier.com/locate/tine](http://www.elsevier.com/locate/tine)



Research paper

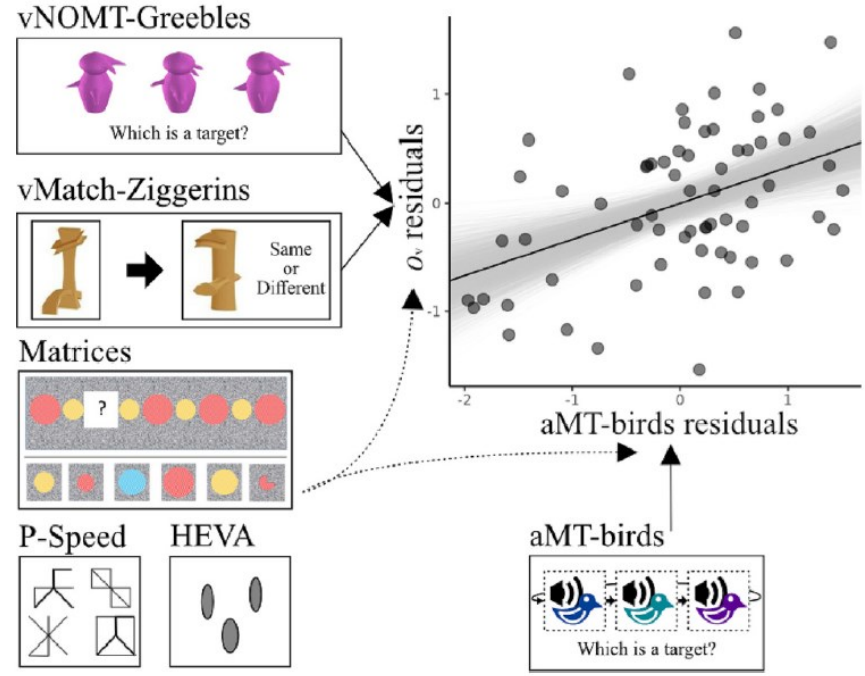
Differential associations of neurobehavioral traits and cognitive ability to academic achievement in higher education

Graham Pluck<sup>a,\*</sup>, Patricia Bravo Mancero<sup>b</sup>, Paola Alexandra Ortíz Encalada<sup>b</sup>,  
Angélica María Urquizo Alcívar<sup>b</sup>, Claudio E. Maldonado Gavilanez<sup>b</sup>, Paola Chacon<sup>a</sup>





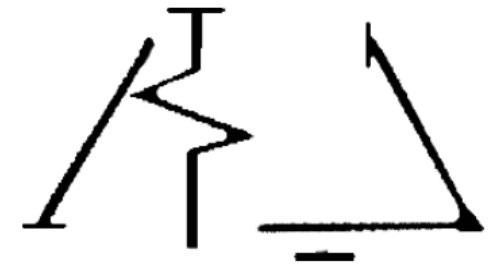
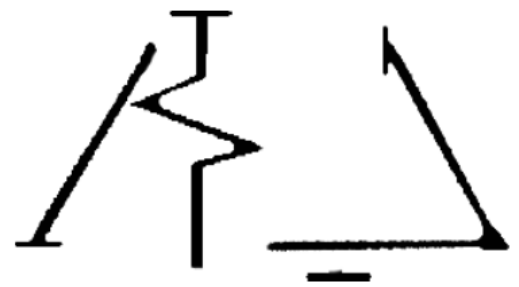
- An alternative maybe object recognition ability.
- We have recently shown that people have a *domain-general* ability to recognise objects.
- This is independent of general intelligence.

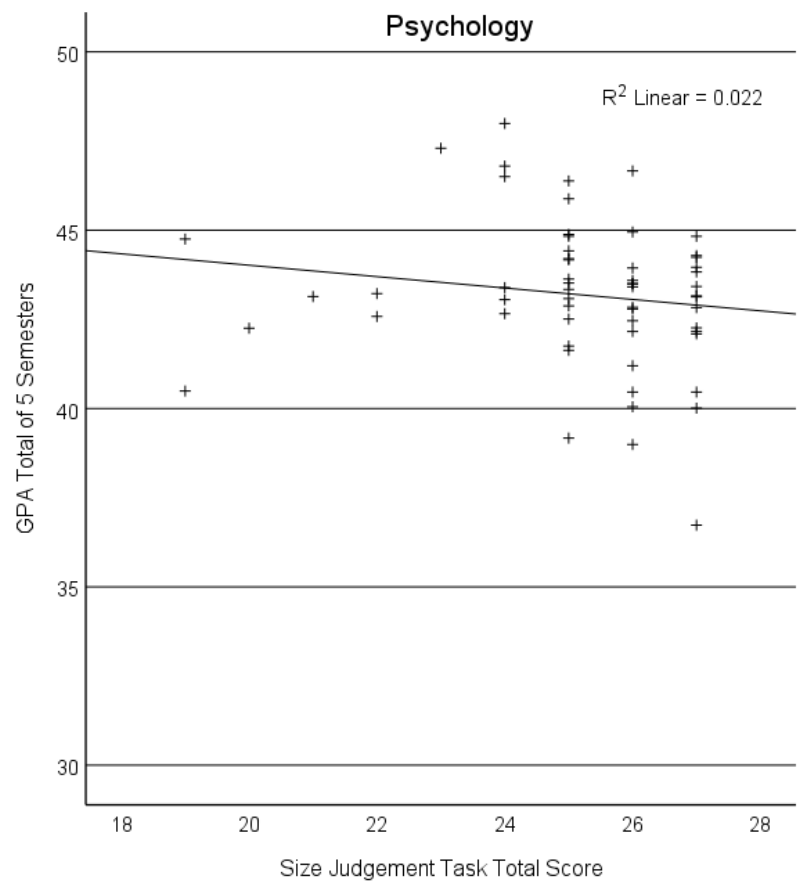
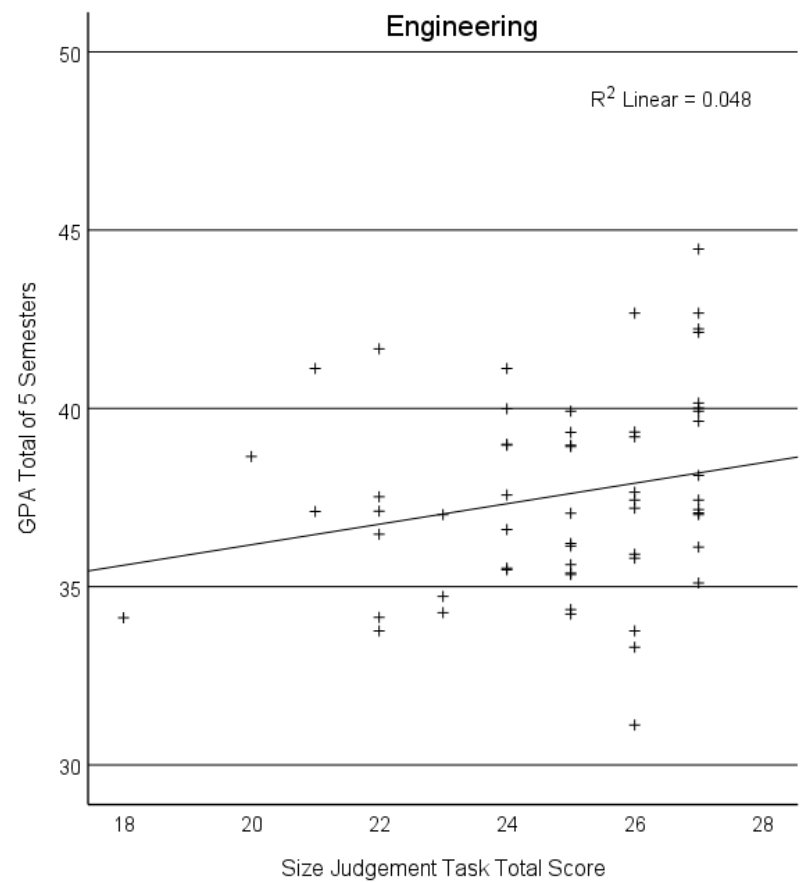




# The 8th International STEM Education Conference 2023

- Size judgement task.
- 27 Trials.
- Completed by:
  - 60 Engineering students
  - 60 Psychology students
- GPA recorded







Sex and age differences between the samples were not responsible for the correlation effects

Sample	Correlation type
	Zero order $r$
Engineering	.25*
Psychology	-.21
All students	.11



## Summary

- Student dispositions include intelligence and personality.
- Variation in these dispositions accounts for half of the variation in university grades.





## Summary

- For STEM students, Intelligence is only part of that.
- Variation in visuospatial abilities also contributes to academic achievement, at least in engineering.





## Some thoughts

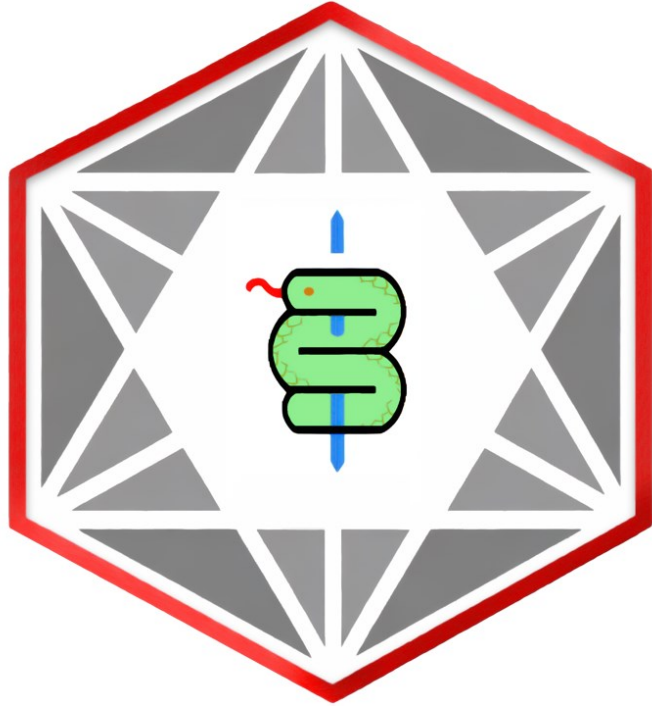
- Selection by intelligence has limitations.
- Visuospatial abilities can be trained, and lead to better GPA.
- Cognitive and brain sciences can help advance pedagogy.

Y. Maeda, S.Y. Yoon, G. Kim-Kang, and P. K., Imbrie, “Psychometric properties of the revised PSVT: R for measuring first year engineering students’ spatial ability”. Int. J. Eng. Educ. vol 29, No. 3, pp. 763-776, 2013.





# The 8th International STEM Education Conference 2023



**CLINICAL  
COGNITIVE  
SCIENCES  
LAB**



@plucklab



@plucklab



Pluck Lab



@DrGPluck