

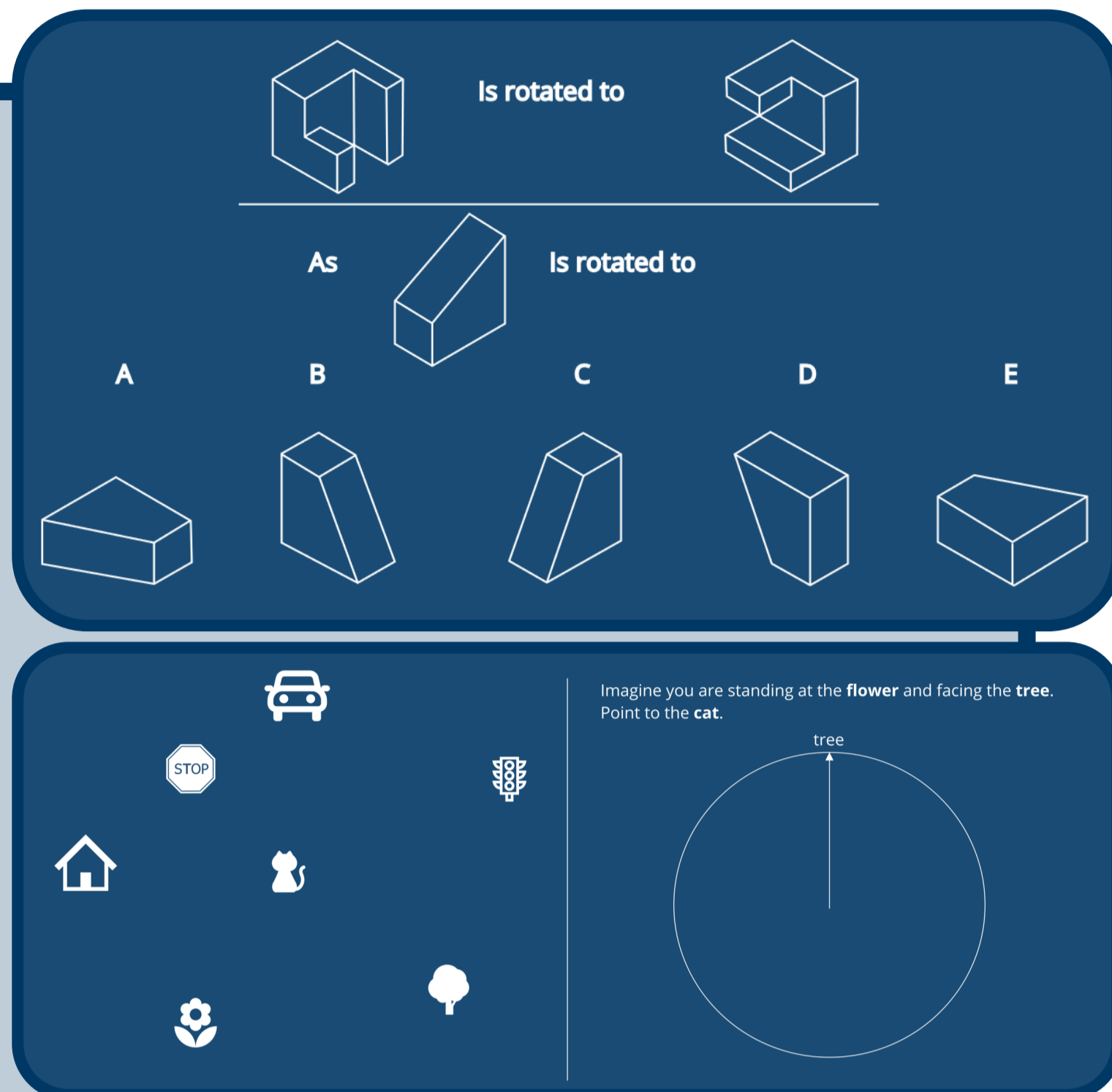
An Overview of the Relationship between Spatial Skills and Computing Science



What are Spatial Skills?

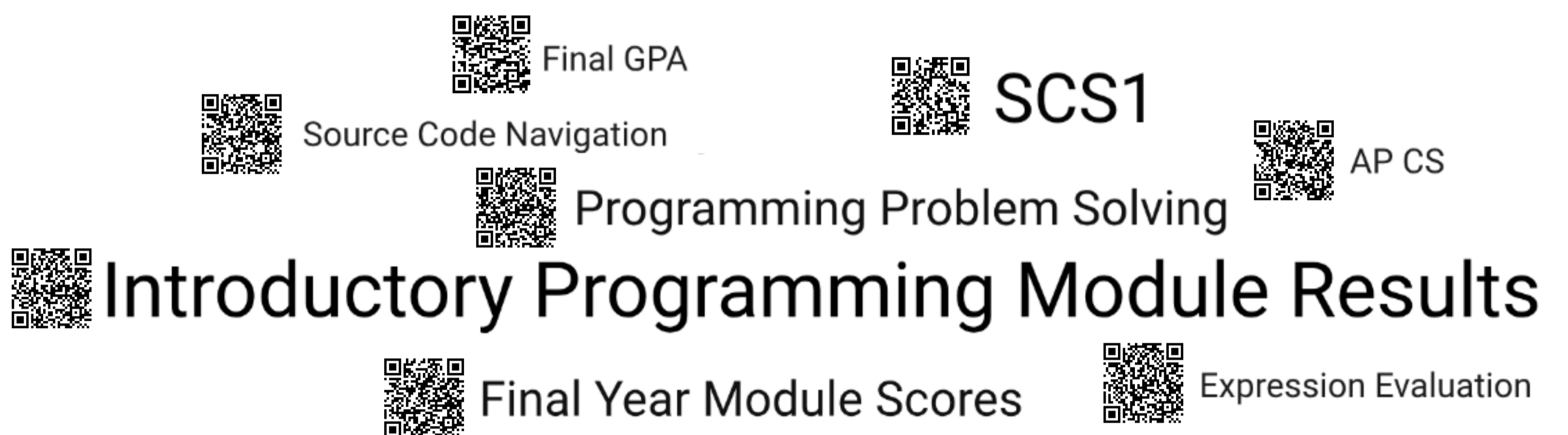
Spatial skills are **cognitive** skills associated with understanding and internally representing space and spatial concepts. Spatial skills include:

- **Spatial visualisation**, including mentally rotating an object or imagining its cross-section
- **Spatial orientation**, including identifying how objects in an environment are oriented to each other (such as in map reading)
- **Spatial perception**, including identifying patterns from obscured or complex environments



Spatial Skills Correlate with CS Success

Correlations and relationships between spatial skills and various CS have been observed in research studies. These include:



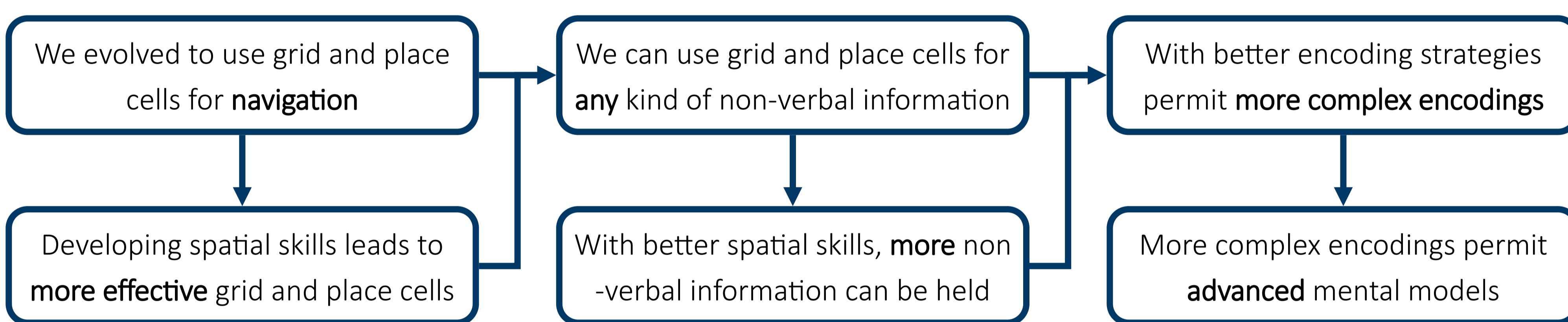
Larger terms indicate that there are more publications involving these measures. Scan the QR codes to see a list of the publications.

Spatial Skills

Why does the Relationship Exist?

Lauren Margulieux presents a theory for the relationship between spatial skills and success in STEM domains called **Spatial Encoding Strategy theory (SpES)**.

The theory connects spatial skills with neuro structures in the hippocampus — grid and place cells — which are used to encode non-verbal information into pseudo-spatial representations.



In practice, the theory proposes that better spatial skills lead to the ability to construct **multiple, complex and overlapping** mental models.

Since much of CS — and indeed, much of STEM — is **abstract and non-verbal**, this theory gives a plausible reason for the wide-reaching relationship.

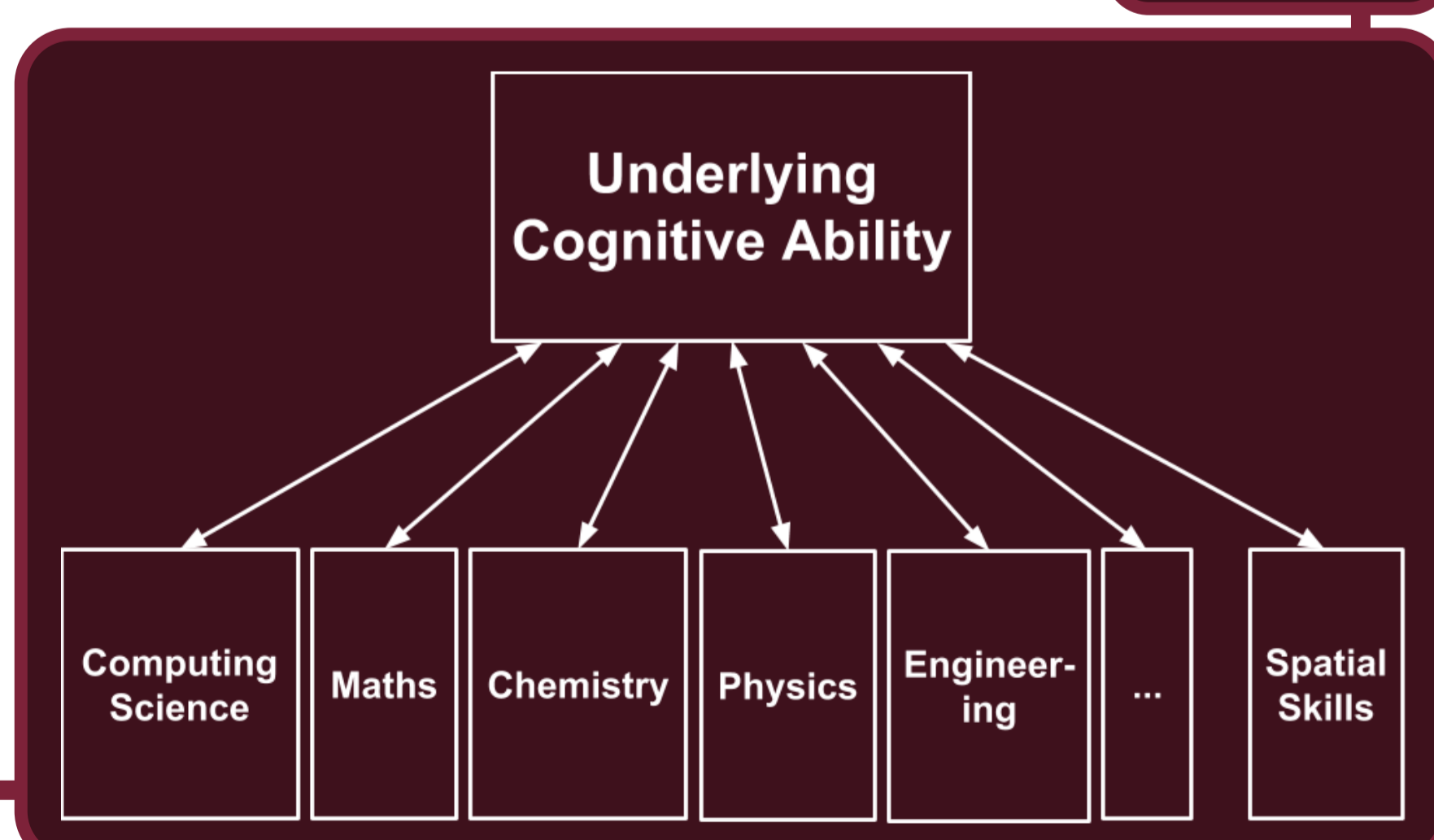
Computing Science

CS Study can Improve Spatial Skills

Since spatial skills are indicative of a broader, underlying ability, it implies that improving them would lead to STEM improvement, but also that **practice in STEM** could lead to **improved spatial skills** too. This has been observed in **Physics** study at a university level.

This has also recently been observed in CS. Students involved in a longitudinal study demonstrated **improvement in spatial skills after a period of CS study** at three institutions, particularly students with initially lower spatial skills.

Find out more about this work by scanning the QR code.



Improving Spatial Skills can Improve CS Outcomes

Multiple studies have been conducted in CS contexts where spatial skills have been actively improved. In most cases, such interventions lead to:

- Improved **spatial skills**
- Improved **computing outcomes** when compared with peers who did not participate

Spatial skills training is a viable route to improving **CS outcomes**, particularly for students with initially weaker skills. Scan the QR code for a full list of spatial skills training interventions in CS contexts.



Open Questions and Future Work

- We know that the relationship lasts right up to the end of university-level study, but what about in **industry**?
- While the trends observed apply broadly, there are often **exceptions**: some students/practitioners have fairly **low spatial skills** and are able to succeed. Why is that? Are there alternatives to spatial and pseudo-spatial strategies? What are they?
- Training spatial skills improves CS outcomes, probably because SpES-related non-verbal encoding strategies are being developed. How can we do this in CS by default without needing **explicit spatial training**?

References and Links

Rather than try to fit all the references for this poster on the print itself, you can find an annotated bibliography at the QR code and links on the right.



Supporting Webpage
jack-parkinson.com/
ukicer2023



Poster Abstract
doi.org/10.1145/3610
969.3611133



Author Profile
gla.ac.uk/pgrs/
jackparkinson/