Improving Computational Thinking with Spatial Skills Development in Primary School

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In summary

Improving spatial skills can improve computing outcomes at a University level

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Improving spatial skills can improve maths outcomes in primary school

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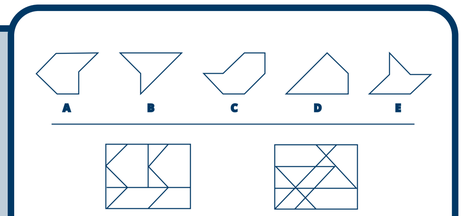
Can improving spatial skills improve computational thinking in primary school?

What are Spatial Skills?



Spatial skills are **cognitive** skills associated with understanding and internally representing space and spatial concepts [8]. 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

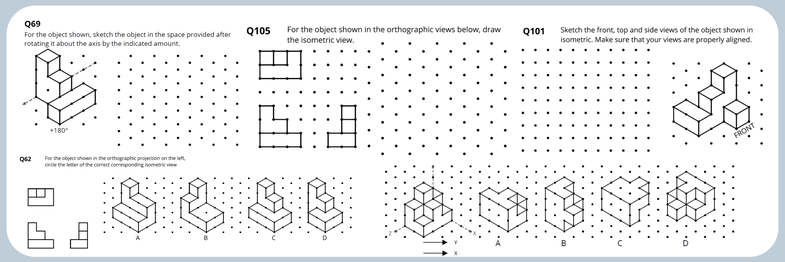
Improving Spatial Skills can Improve CS Outcomes

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

a) Improved **spatial skills**

b) Improved **computing outcomes** when compared with peers who did not participate

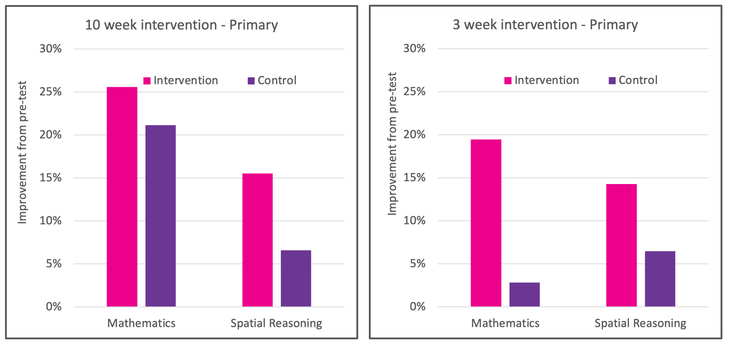
Studies have been conducted in at least five institutions in university-level introductory computing [1, 2, 7].



However, it is rare for studies to be conducted outside a university context, particularly with respect to computing, so how these skills interact with learning in K-12 education is not well explored.

Spatial Skills Development Exists in Primary School and Improves Maths Outcomes

The MathsBURST programme, developed by Tom Lowrie in Australia, is now fairly widely used in Australian schools. It is a curriculum which spatialises some maths lessons, so that pupils can learn the typical maths curriculum infused with some specific exercises and activities to develop spatial skills [3, 4, 5].



Intervention 1, 2017 ***Intervention 2, 2019***

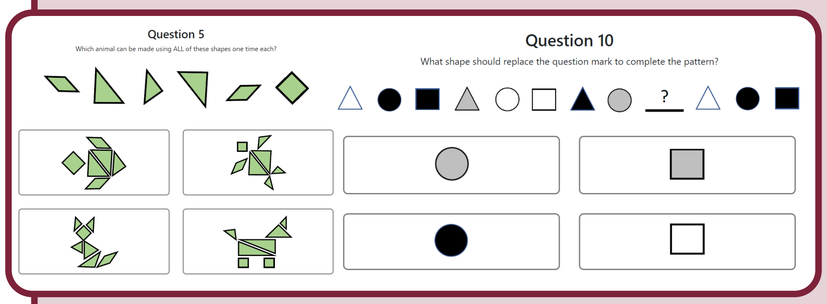
MathsBURST develops spatial skills through visualisation and prediction activities and through a framework which draws from several dimensions (experiential, pictorial, symbolic, etc.) to encourage more spatial reasoning.

Why does the Relationship Exist?

We have cells in our hippocampal lobe which we originally evolved for navigation, but in fact we can use these cells for all kinds of spatial and pseudo-spatial mappings. These include but aren't limited to: diagrams, mental models, program structures, hidden mechanisms and notional machines. Anything non-verbal we need to keep in our heads! If we improve our spatial skills, these cells become more effective, so we can encode more (complex and overlapping) information at once, leading to more complex and structured understanding.

Our Project: MathsBURST in Scotland for Spatial and Computational Thinking Development

Our project will investigate whether spatial skills development through the MathsBURST curriculum will improve computational thinking outcomes for pupils in Scottish primary schools. Among other measures [8], we will be conducting pre– and post-tests with the DEVTECH **TechCheck-2**, an unplugged CT assessment for children aged 7-9 [9].



The **STEM SPACE Project** has recently launched with 30 classes across 3 local authorities involved. The goal is to support teacher delivery of MathsBURST materials until December, which is when we will conduct post-tests in CT. We also have several control schools involved to use as baseline measures, who will be using a more typical maths curriculum which doesn't explicitly develop spatial skills

We plan to compare pre– and post-test results across both control and experimental groups to determine if spatial skills improvements lead to (more substantial) improvements in CT scores.

References

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