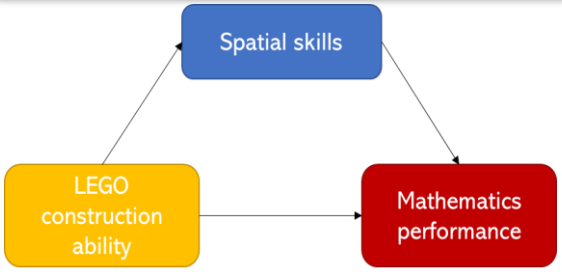
Spatial Cognition to Enhance Mathematical Learning (SPACE): Research Summary

The SPACE Programme

The aim of the SPACE programme was to determine the impact of Lego® block construction sessions, paired with teacher training, on children's spatial language, spatial skills and mathematics competence.

Background information about block construction

Building with blocks uses a range of skills. Our research has shown that this includes spatial skills such as mental rotation (the ability to imagine the movement of an object in your mind's eye), disembedding (understanding of parts and wholes), number estimation, and visual memory. These same abilities are used for mathematical thinking and we have shown that block construction ability is related to mathematics performance.



Background on children's spatial skills and mathematics performance

Spatial reasoning is the ability to understand the spatial properties of objects such as their size and location, and to visualise objects and problems in the mind. These skills are important for children's development because children need to reason spatially in many aspects of their lives: comparing shapes, gesturing and exploring in the playground, knowing whether they will fit in a hiding place, and map-reading.

Research has shown that children who are better at spatial reasoning tend to be better at mathematics. This is because mathematics draws on spatial skills. For example, the ability to visualise and manipulate objects in space helps children to solve geometry problems, missing-number equations and addition problems.

Mental rotation

$7 + \_ = 15$

becomes...

$15 - 7 = \_$

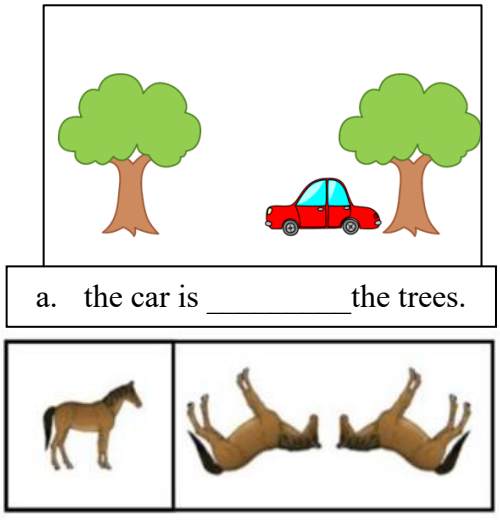
Why was it important to do this research?

Our previous study demonstrated that children's spatial skills and some mathematics skills improved when they took part in block construction activities in an extra-curricular activity with a teacher. SPACE sought to investigate whether these improvements could work when the programme is delivered by a teacher in a whole class setting within the children's mathematics lesson time. Teachers also received professional development prior to delivering the SPACE sessions as well as associated resources (videos, posters & prompt cards).

How we carried out the study

We worked with 409 children 6- to 7-year-olds from 15 primary schools. Children completed 12 SPACE sessions within class time for mathematics over a six-week period.

SPACE sessions: Each child was given a booklet with picture instructions of six Lego models to build each session and every week there was a different fun theme, such as Scientists or Superheroes. Teachers and teaching assistants delivered prompts (including spatial language) during the SPACE sessions to encourage children to use spatial thinking when building the models, for example, "try turning the brick in your mind". Children were assured that accuracy was more important than speed and they were not expected to build all the models in the booklet. A further group of children (the control group) did not take part in the SPACE programme but completed their normal mathematics lessons.



Measures of spatial skills and mathematics performance: Before and after the six week period, the children completed a series of tasks so that we could investigate whether their performance had changed as a result of taking part in the SPACE sessions.

We assessed spatial language and mental rotation (a spatial skill) and mathematics.

Our findings

We wanted to know whether the SPACE programme would have a positive impact on the spatial and mathematics abilities of 6- to 7-year-old children.

We found that:

1. Children who took part in the SPACE programme **showed improvement in their spatial skills and mathematics performance** compared to control children who did not take part.

2. The programme was **enjoyable** and **pupils engaged well** with the visual instructions **removing potential barriers to learning.**

3. Positive effects were observed on children's **fine motor skills, resilience, perseverance and confidence.**

4. Block construction training was **easy for teachers to deliver** but some expressed a **challenge fitting it into the existing curriculum content.**

Overall the SPACE programme was SUCCESSFUL!

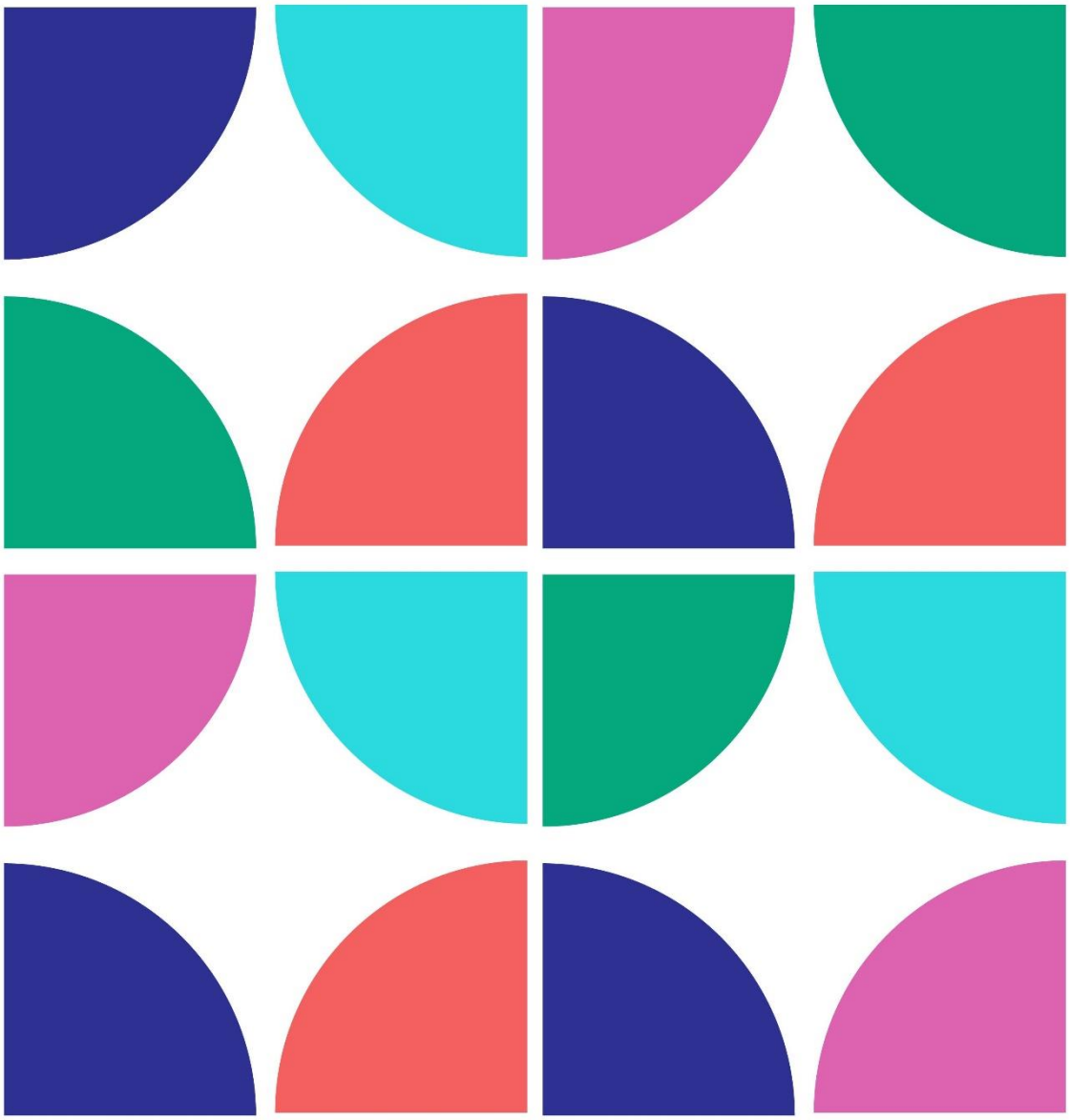
Recommendations

- ✓ Teachers include spatial activities and use physical manipulatives as part of a spatialised curriculum to support children's mathematics learning.
- ✓ Teachers are provided with professional development on the importance of spatial reasoning for mathematics.
- ✓ School curricula are updated so that content is informed by recent evidence such as this study. Currently, spatial reasoning is largely missing from mathematics curricula.

➡ The SPACE programme was also one of the first studies not to be delivered by a research team but instead, the researchers trained teachers to carry out the programme. A next step would be to work with teachers to co-produce a **spatialised mathematics curriculum**

For practitioner resources, policy briefings and further research see our spatial reasoning platform.

SPACE



Thank you for reading about our research.

A special thank you to the children, teachers and teaching assistants who participated in this study, to their parents, and to the schools for accommodating us.

SPACE