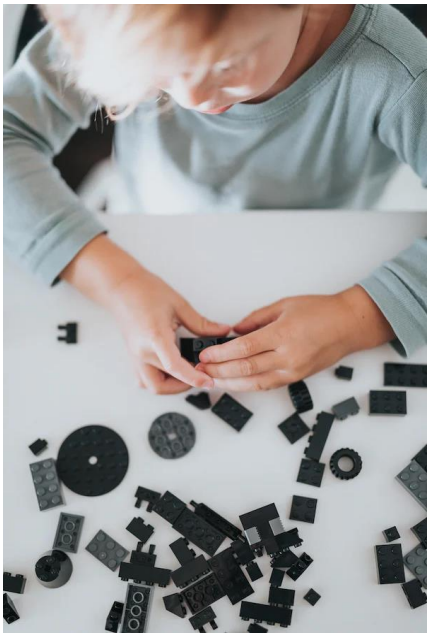
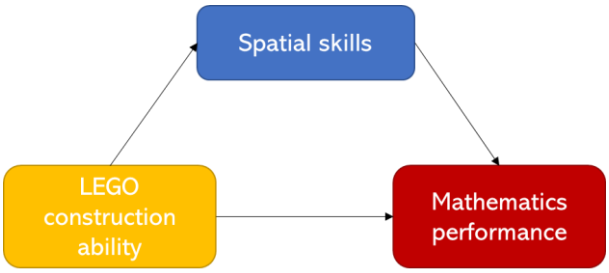
The BLOCs study in more detail

Our research aimed to investigate the impact of LEGO® construction training on children's mathematics and spatial reasoning skills.

Background information about LEGO® construction

Lego is one of the most popular toys worldwide. Despite its popularity, there hasn't been much research investigating the influence that Lego construction activities may have on children's cognitive abilities and academic achievement. Building with Lego uses a range of skills; our own 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 visuospatial working memory. These abilities are also used for mathematical thinking, which we have also shown is related to Lego construction ability.





Because there is already promising evidence to suggest that Lego construction ability is related to both maths and spatial skills, it is possible that Lego construction activities can be used to support spatial reasoning and mathematical development. This study will be the first investigation into whether Lego construction training can lead to improvements in these areas.

Background information about children's maths and spatial skills

Spatial reasoning involves perceiving the location and properties of objects and the distances between them. These skills are important for children's development because children need to reason spatially in many aspects of their lives. Examples include comparing shapes, learning about anatomy in a science lesson, gesturing and exploring with other children in the playground, knowing whether they will fit in a hiding place, and map-reading.

Maths skills are also important for children's development. We use maths skills in daily life, for example, using money and getting to an appointment on time, and many career paths require strong maths abilities.

Mental rotation

$7 + \_ = 15$

becomes...

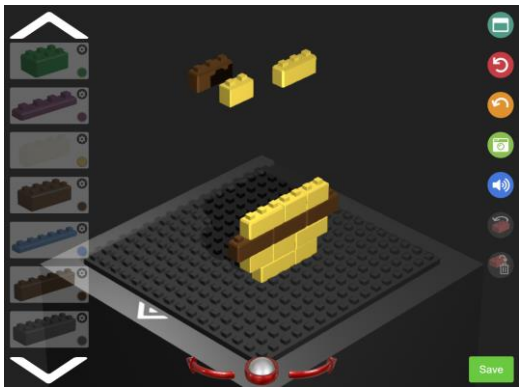
$15 - 7 = \_$

Research has shown that children who are better at spatial reasoning tend to be better at maths. This is because maths draws heavily on spatial skills. The ability to visualise and manipulate objects in space helps children to solve geometry problems. In addition, spatial reasoning is important for children's numeracy skills, such as understanding how symbols are arranged in equations, solving missing-number equations by mentally rearranging the locations of the numbers, and solving addition problems by imagining two sets of dots coming together.

The role of digital technology in maths and spatial skills

Some popular video games like Minecraft and Lego Worlds involve block construction activities and so, like Lego, these games might be relevant for children's maths and spatial skills. We felt it was important to investigate a digital version of Lego, as a digital training programme may potentially be a more viable and cheaper option for many educational settings.

Our previous study indicated that both physical and digital Lego construction skills are related to children's spatial and maths abilities. We therefore created both physical and digital Lego training programmes so we could investigate whether digital block construction skills have an impact on maths and spatial skills, and if so, whether this is different from using physical Lego bricks.

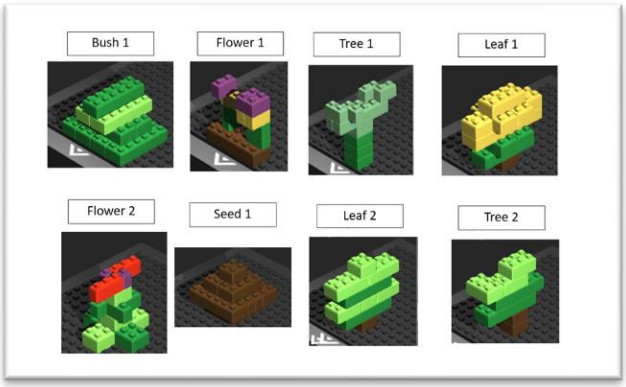


Why was it important to do this research?

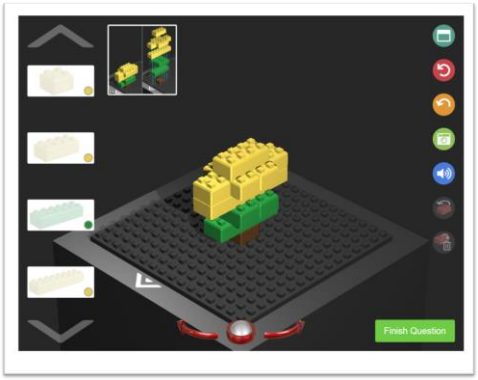
Our findings have educational implications. Research shows that children's spatial skills can be improved with training. Spatial training programmes often lead to improvements in maths skills too, because of the link between children's spatial reasoning and their maths skills. We know that Lego construction taps into the same spatial skills as in maths, so construction toys such as Lego could be used in spatial training programmes aimed at improving children's spatial and maths skills.

The BLOCS Lego and crafts programmes

Children took part in one of three different programmes designed by us: physical Lego club, digital Lego club, or crafts club (active control group). The purpose of the control group was to give us something to compare our Lego groups to. Each week had a fun theme, such as *Scientists* or *Superheroes*.



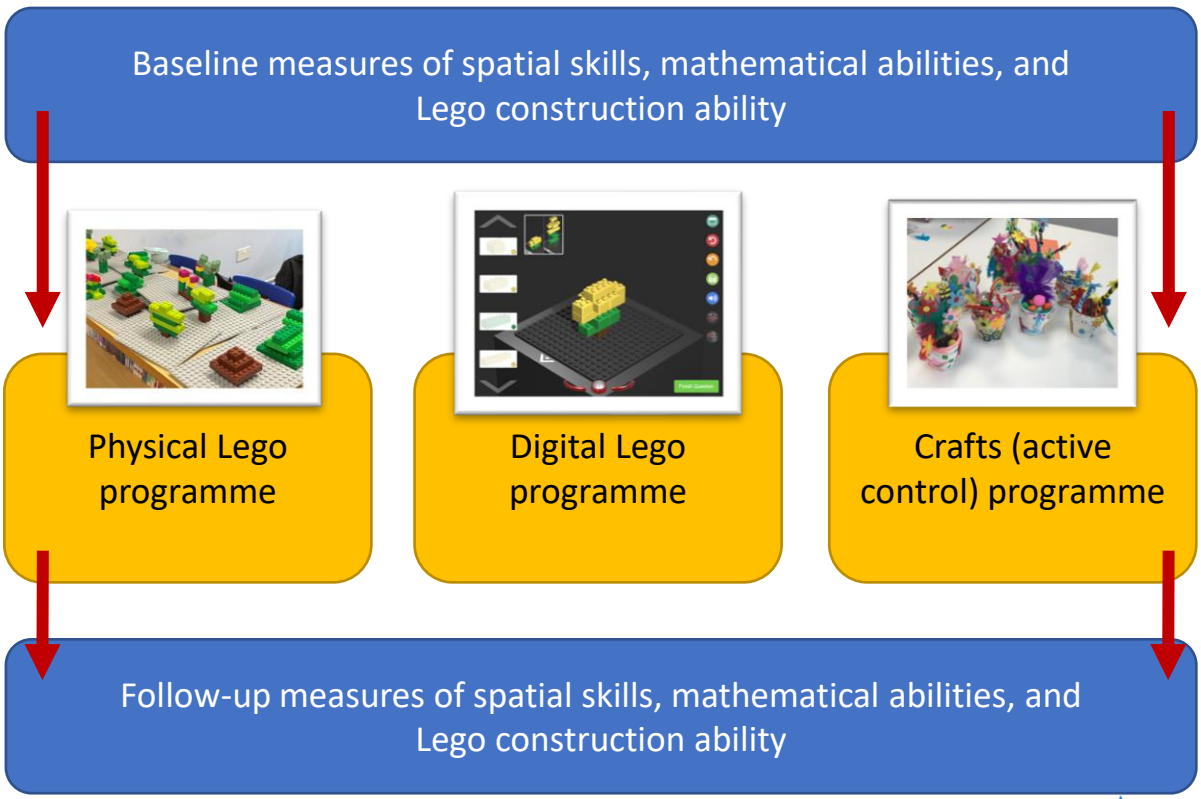
Children who took part in one of the Lego clubs were given a booklet filled with eight different Lego models to build each session. Those doing the physical Lego club were given the physical Lego bricks needed to complete the models. The children in the digital Lego group built their models using our digital Lego platform.



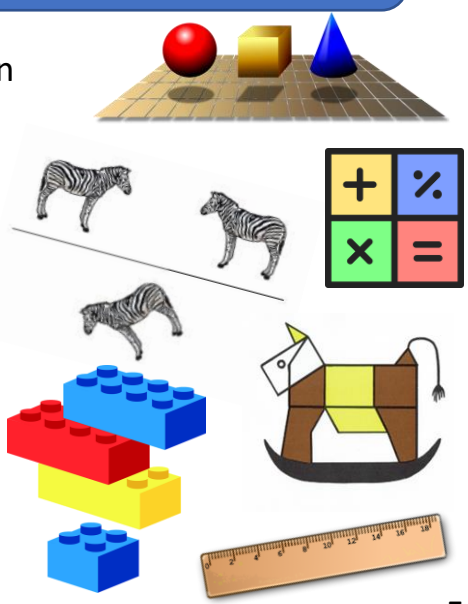
The crafts club followed the same themes but involved crafting activities such as decorating plant pots and superhero masks.

How we carried out the study

We worked with 198 Year 3 and 4 children in seven different primary schools. Children took part in a 12 session group intervention, delivered as a lunchtime club, over a six week period. They took part in either the physical Lego club, digital Lego club, or the crafts club.



Before and after they took part in the clubs, children completed tasks that measured their spatial skills, maths performance, and Lego construction ability. This was so that we could investigate whether their performance had changed as a result of the intervention.



We assessed spatial skills that are important for maths and Lego building, such as mental rotation, and disembedding. For maths, we assessed numeracy, geometry, and problem solving.

Our findings

This was the first study to deliver a Lego training programme within school settings, with the aim of evaluating impact on spatial ability and mathematics performance. We also aimed to compare the findings found in each intervention group; physical Lego, digital Lego, and crafts, to determine which type of training has the most significant impact on children's spatial and maths abilities.

We found that physical and digital Lego training improved Lego construction ability compared with crafts activities

Spatial ability did not improve as a result of Lego training

We found some evidence of improvements in arithmetic as a result of digital Lego training, relative to the other two groups

Performance in geometry and overall mathematics ability did not differ across the three groups

We've created a guide, in which you can find some ideas for using Lego construction activities in a maths context at home or at school.

What do these findings mean?

While our findings show limited impact of Lego training (i.e., Lego construction ability improved in both Lego groups, and arithmetic improved in the digital Lego group only), there are several explanations as to why this happened.

Our study relied on the idea that an implicit training effect would take place during the Lego interventions. However, our findings imply that the explicit use of spatial language, feedback, or reference to using spatial strategies (as seen in other studies), may be necessary for transfer to spatial and maths abilities.

Another important factor is that our interventions took place during the children's free time (lunch time). Perhaps for future training programmes to have a larger effect, they should take place within a mathematics learning context.

What are we doing with our research?

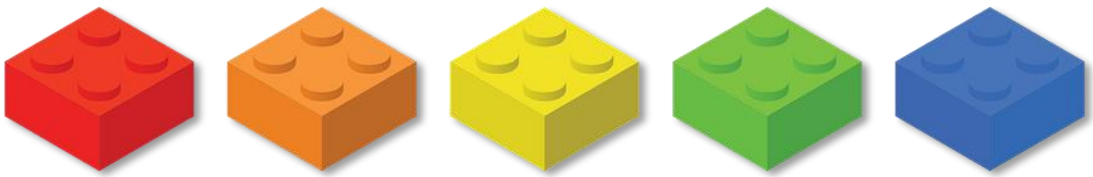
We are currently planning to conduct a related study investigating the suitability of the Lego training programme on younger children during maths lessons. This new project, the SPACE programme, will start in schools in Autumn 2023.

SPACE
SPATIAL COGNITION TO ENHANCE MATHEMATICAL LEARNING

Based on our BLOCs findings, the two key additions to the SPACE programme are:

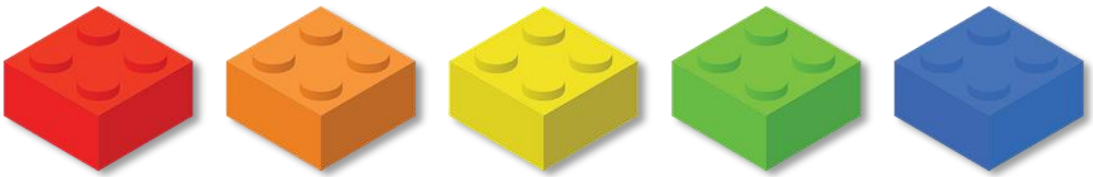
1) The SPACE programme will be delivered in mathematics lessons
2) The SPACE programme will include explicit references to spatial strategies. This will be accomplished via teacher training, so that the teachers are equipped to use spatial strategy prompts while children are constructing Lego models, for example: "try turning the brick in your mind".

Based on the research literature, our team is confident in the benefits of Lego on children's spatial and maths skills.



Thank you for reading about our research.

A special thank you to the children who participated in this study, to their parents who signed them up, and to schools for accommodating us.



Block Construction Skills For Mathematics

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