

Bee Spatial: Research Summary



October 2026

Spatial abilities

Spatial abilities allow us to:

- understand the location, shape and position of objects, and how they relate to one another.
- visualise objects by mentally representing and manipulating them.
- use tools such as spatial language, gesture, graphs, sketches and maps to externalise and organise our thinking.



Introducing Bee Spatial

Bee Spatial is a collaboration between Prof. Emily Farran and Angelina Orav at the University of Surrey, Jane Brown at White Rose Education, and Prof. Camilla Gilmore at Loughborough University. Bee Spatial is a classroom-based programme of spatialised mathematics for Year 3 pupils, delivered by teachers as part of everyday maths lessons and designed to fit naturally alongside materials schools already use.

The Bee Spatial programme centres on spatial visualisation, which is the ability to picture, manipulate and reason with mental images. Spatial visualisation is a foundational spatial skill that underpins key areas of mathematics, including fractions, measurement, geometry and problem-solving. Teachers also provided input by modelling the use of spatial language and gesture, and encouraging children to represent their visualisations using drawings, manipulatives, gesture or explanation.

The aims of Bee Spatial align with priorities for mathematical learning identified in the Curriculum and Assessment Review, which emphasises the importance of mathematical reasoning and problem-solving. This includes pupils' engagement with non-routine problems that demand flexible thinking rather than the application of memorised procedures.

The evidence base for Bee Spatial

Spatial abilities play a key role in mathematical development. Research spanning 45 studies has shown that children with stronger spatial skills tend to perform better in maths (Atit et al., 2022). This relationship is well established, with Mix and Cheng (2012) stating that “*the connection between space and math may be one of the most robust and well-established findings in cognitive psychology*”.

Importantly, spatial abilities can be trained. A review of 29 studies by Hawes et al. (2022) found that spatial training improve both spatial and mathematical competence, highlighting the potential for spatial abilities to support mathematical development. Spatial thinking has broad benefits for mathematics, including geometry, measures, number, fractions and statistics (Gifford et al., 2024). Spatial training has also been shown to narrow mathematics attainment gaps (Bower et al., 2022; Resnick & Lowrie, 2023).

Bee Spatial is also based on evidence that spatial training programmes that are embedded into mathematics content are more effective than isolated programmes (Lowrie et al., 2023), and that teacher input provides benefits over and above the spatialised material (Resnick & Lowrie, 2023).

See it. Show it. Solve it.



The Bee Spatial programme

Teacher training and classroom delivery

Participating schools took part in the programme within a school term. Teachers received training and support from the Bee Spatial research team before delivering 'spatialised' maths lessons for five weeks (see the examples of spatialised maths content below). These include mental image manipulation such as rotating pictures or folding a shape through spatial visualisation, use of spatial language and gesture, and spatial representation using drawings, manipulatives, gesture or explanation. Teachers were also invited to a debrief session after Bee Spatial had completed.

How was Bee Spatial received?

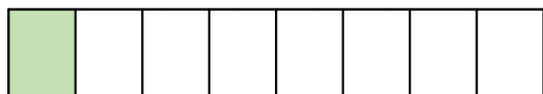
Researchers conducted teacher and child interviews to track their progress and understand their perspectives on Bee Spatial and mathematics. Teachers also provided feedback by completing surveys and by attending teacher check-ins.

Example Bee Spatial content

Here is $\frac{1}{8}$

Imagine shading two more eighths.

Describe what you see.

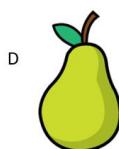
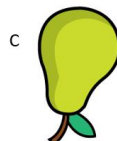


White Rose
MATHS

UNIVERSITY OF
SURREY

Loughborough
University

Which pear is different to the rest?



Tip: Imagine turning the pears the right way up.



White Rose
MATHS

UNIVERSITY OF
SURREY

Loughborough
University

Results - Children's perspectives

Visualisation – visualisation became a more explicit strategy.

"Sometimes I see the answer in like my head and then I write it down and then most of the time I get it correct. So I keep on using it."

"It was very fun and I really liked trying to like, like trying to imagine it because I just like got my brain really working and I just really like that."

"I didn't actually use to visualise before, only on like folding stuff. But now that I actually got to know that you could actually visualise..."

Confidence and inclusion – Bee Spatial increases children's mathematics confidence.

"We started pausing, take a moment to think..."

"It is very helpful because you basically, you can actually think about it instead of just rushing in."

"I think it can make you more confident and also, like, just to help, just helps a little bit."

Engagement and enjoyment – learning mathematics became more engaging and enjoyable.

"I like maths a bit better."

"It made me a bit better at maths..."

"It just gives you more options how to figure stuff out."

Gestures, representations and different ways of thinking - - Children were able to represent their visualisations through gestures, for example, drawings and using their hands.

"So I pretend that I was holding this strip of paper like that and I was like folding it and then fold it again."

"I did use my hands because it was very helpful."

"I'd draw the scale..."

Results – Teachers’ perspectives

Visualisation – visualisation became a more explicit strategy.

"I enjoyed giving the children the opportunity to really visualise their maths problems. It was interesting to see their responses."

"The children have all really enjoyed visualisation and recording their workings out in their own way. Bee Spatial made this very explicit and it is something that I will continue to use in our maths sessions."

Confidence and inclusion – Bee Spatial increases children’s mathematics confidence.

"The lower attaining pupils, in particular, benefitted from slowing down and spending that time visualising the problem before writing the answers. It gave them another strategy to use when trying to work things out."

"It was wonderful to see many of them grow in confidence, with some children feeling more willing to have a go at maths as a result."

"It raised the confidence of some of the children who said that they found maths challenging at the beginning of the year, this is not now the case for those children"

Engagement and enjoyment – learning maths became more engaging and enjoyable.

"Overall enjoyment in maths and particularly fractions which can be a daunting thought to some children."

"The children found it a really fun and engaging way to learn maths."

Gestures, representations and different ways of thinking.

"The gesturing while visualising has helped pupils to apply knowledge to problem solving in fractions and mass and capacity."

"Children were always excited to show their workings out to solve problems and it was good for all of them to see how differently children thought."

Results – Teachers' perspectives

Teacher Survey responses

100%

Strongly
agree

- ❖ Overall, children in my class enjoyed and engaged well with Bee Spatial.
- ❖ Children in my class with low numeracy skills enjoyed and engaged well with Bee Spatial sessions.
- ❖ Children in my class with SEND enjoyed and engaged well with the Bee Spatial sessions.

86%

Found Bee Spatial to be extremely/very feasible to deliver alongside other curriculum demands during this term.

100%

Strongly agree or agree that they could see Bee Spatial becoming a regular part in their maths teaching.

100%

Responded yes when asked if they intended to incorporate strategies for teaching spatial reasoning into their maths teaching or classroom support for their Year 3 class next term/year.

See it. Show it. Solve it.



Summary

Bee Spatial is grounded in robust scientific evidence and is accessible to all children, suggesting that it has strong potential to narrow attainment gaps.

The program builds children's confidence in mathematics and encourages flexible problem-solving, while creating an engaging and enjoyable experience for both teachers and children.

The program requires no additional resources, or teaching time because it is embedded into daily maths lessons.

It supports the Curriculum and Assessment Review recommendations to provide more opportunities for problem solving.

Thank you for reading about the Bee Spatial pilot trial.

Bee Spatial webpages: <https://www.surrey.ac.uk/bee-spatial>

For more on spatial reasoning: <https://www.surrey.ac.uk/spatial-reasoning>

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.

