Make Space; the value of spatial reasoning for mathematics

22nd May 2025, University of Surrey. Organised by Prof. Emily Farran

We will continue to update our spatial reasoning platform - please share it with your networks.

Overview

The Make Space event took place at the University of Surrey in May 2025. It took place in the context of the change opportunity brought about by the 2025 Curriculum and Assessment Review in England and growing recognition of the value of spatial reasoning for mathematics and STEM in national discussions. A resounding success, the event brought together representatives from key sectors. To best enable group discussion, the event was limited to 54 attendees. Through presentations and panel discussions, we discussed the need to equip the next generation to meet the heightened demands for problem solving and data use, and that teaching children to think and work spatially is an evidence-based, inclusive route to achieving this goal. The opportunities provided at the event to discuss collective action towards meeting this goal were met with energy and enthusiasm, with most attendees committing to actions.

Research and policy context[1]

Spatial abilities include the ability to understand the spatial properties of objects such as their size and location, and the ability to visualise and manipulate objects and problems in the mind (Farran et al., 2024). We use spatial abilities every day: to pack a bag, read timetables, and find our way. A robust finding in cognitive psychology is that training children's spatial abilities can significantly improve mathematics performance. In England spatial reasoning remains underrepresented in the National Curriculum. This neglect in teaching children to think and work spatially is already evident in England's latest PISA and TIMSS results where 'shape and space' and geometry sub-domains are weak relative to other areas of mathematics. If spatial reasoning remains a low priority in schools, there is a risk that the next generation will not be prepared to meet the demands of the AI and data-driven employment revolution.

National discussion

The value of spatial reasoning for mathematics and STEM is gaining recognition in national discussions and is of direct relevance to the ongoing Curriculum and Assessment Review.

- Ofsted (2024): *"Understanding both number and spatial reasoning is crucial to later achievement"*
- Royal Society Mathematical Futures (2024): *"there should be greater emphasis on conceptual understanding and a stronger focus on spatial reasoning"*
- Royal Society Advisory Committee on Mathematics Education (ACME) (2024): *"Spatialising the mathematics curriculum by emphasising thinking and working spatially has broad benefits for mathematics, including geometry, measures, number, algebra and statistics."*
- Maths Horizons (2025): *"[Curriculum] often neglects the purpose, progression and "habits of thinking" that underpin [content], such as spatial reasoning..."*

[1] A version of this paragraph was published in a recent TES article on spatial reasoning.

Summary of the "Make Space" event

Encouraged by recent national discussion, the "Make Space" event brought together representatives from key sectors to discuss the value of teaching children to think and work spatially. Attended by professional development providers, practitioners, resource providers, policy advisors, government officials, researchers and maths education specialists, a goal of the event was to discuss connections between the evidence base, and current and future policy and practice. Across three presentations, attendees were informed of the latest research on the value of spatial reasoning for mathematics and how this evidence is being used in settings and classrooms. An interactive panel discussion on "Spatial thinking, Mathematics Curricula and STEM Futures" followed with key experts in mathematics education policy and practice.

Presentations

- Spatial reasoning for mathematics; taking research to the classroom – Prof. Emily Farran, *University of Surrey*

  Prof Emily Farran provided an overview of the evidence base to highlight the critical role of spatial reasoning in supporting mathematical achievement and broader STEM success. She emphasised that spatial skills are trainable and promoted the importance of embedding spatial reasoning within existing mathematics content to address future workforce needs. As an example, she introduced the recent SPACE teacher-led training study, which demonstrated significant improvement in children's spatial and mathematics performance and benefits to inclusion. In support of the need for professional development, guidance and resources, Prof. Farran outlined the Spatial Reasoning Toolkit, a collaboration with the Early Childhood Maths Group, and other resources.

- Spatial sparks: Inspiring Classroom Practices and Practical Insights – Katie Breese, *The Howard Partnership Trust* & Phil Hutson, *NE Hants & Surrey Maths Hub*

  Katie Breese and Phil Hutson outlined their experiences in inspiring classroom practices, giving practical insights on embedding spatial reasoning into the classroom. Katie demonstrated how she had used the Spatial Reasoning Toolkit and highlighted simple, low-cost ways to enrich spatial opportunities through everyday classroom practice and staff development. Phil explored how spatial skills such as visualisation (that is, using a mental blackboard) support maths learning. He also provided examples of using spatial language as a tool to support spatial and mathematical understanding. Both emphasised that spatial reasoning is foundational, not an add-on, and key to improving outcomes in number and broader mathematical thinking.

- What do we/can we (not) learn about spatial reasoning from international large-scale mathematics assessments? – Prof. Jenni Ingram, *University of Oxford*

  Prof Jenni Ingram enlightened the audience with evidence from international large-scale mathematics assessments. She presented data from the Programme for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS) which demonstrated persistent underperformance in spatial reasoning and geometry among UK students relative to other countries. Low levels of performance in spatial reasoning and geometry were evident across all attainment levels and contrasted with relatively strong performance in other areas of mathematics. She called for greater focus on visualisation and other spatial skills to develop children's spatial reasoning skills.

Discussant – Dr Sue Gifford*, University of Roehampton*

Talks were expertly summarised by Dr Sue Gifford. She emphasised that we are "missing a trick", particularly given the benefits of spatial reasoning to groups such as girls, non-verbal children and low-attaining children. She re-iterated the importance of including opportunities to use the spatial skill of visualisation in mathematics, highlighting existing professional development such as the NCETM spatial reasoning pathway, and existing resources such as our trajectory of development of spatial reasoning (birth to seven years and seven to eleven years).

Panel Discussion: Spatial thinking, Mathematics Curricula and STEM Futures

Panel members

- Catherine Boulton, *Policy lead on Mathematics Education, Royal Society*
- Dr Helen Drury, *Co-Lead of Maths Horizons*
- Jane Brown, *Head of Primary Maths for White Rose Education*

Talks were followed by an interactive panel discussion with key experts in mathematics education policy and practice. Panelists engaged with attendees to explore the importance of spatial reasoning as a critical, evidence-based component of mathematics education. A central theme was that there is strong evidence and scalable practice ready to inform policy. Discussion centred on how best to inform policy. Limitations were considered in terms of current assessments, level of teacher awareness and the need for professional development in spatial reasoning to be prioritised. Consideration was given to how best to communicate that spatial reasoning is not another topic to be taught, but that existing content can be 'spatialised'. Discussion moved to the need for a coherent national approach, that is, that embedding spatial reasoning requires coherence across curriculum, assessment and teaching practice. An agreed next step was to form a "Make Space" network to continue discussion and influence.

Key messages from the Make Space event

1. Spatial abilities are foundational to mathematics, STEM and wider problem solving.
2. ALL children can be taught to think and work spatially. Spatial reasoning offers a powerful means to unlock potential, particularly for 'left behind' groups, providing a route to closing attainment gaps.
3. Spatial reasoning does not require additional activities - existing content can be spatialised (without waiting for national changes).
4. There is a need for a coherent national approach to embed spatial reasoning across professional development, curricula and policies.
5. There is a growing momentum across the sector, with policy documents increasingly stating the central role of spatial reasoning for STEM. There was a strong appetite from the attendees of the event for cross-sector collaboration to further scale this message.

Summary of actions shared by attendees

We asked attendees to commit to actions towards "*teaching children to think and work spatially*". Sixty-six actions were anonymously shared live on-screen at the event via online text input. A feedback form distributed after the event also asked respondents whether they planned to take action, and to provide details. Overwhelmingly, 31 out of 32 respondents answered "Yes" they would be taking action, with one "Maybe" by a respondent who explained that they were already taking action. Actions from both entry formats were used to conduct a thematic analysis, noting that there might be duplication from the same attendees across the two formats of response. Thematic analysis of actions was co-produced using the AI tool Chat GTP.

Themes of attendee actions: teaching children to think and work spatially

Attendees committed to:

1) raise awareness through publications and stakeholder engagement

2) embed spatial reasoning into professional development and training across all phases

3) integrate spatial reasoning more deeply into curricula and teaching practice

4) generate new research and building the evidence base

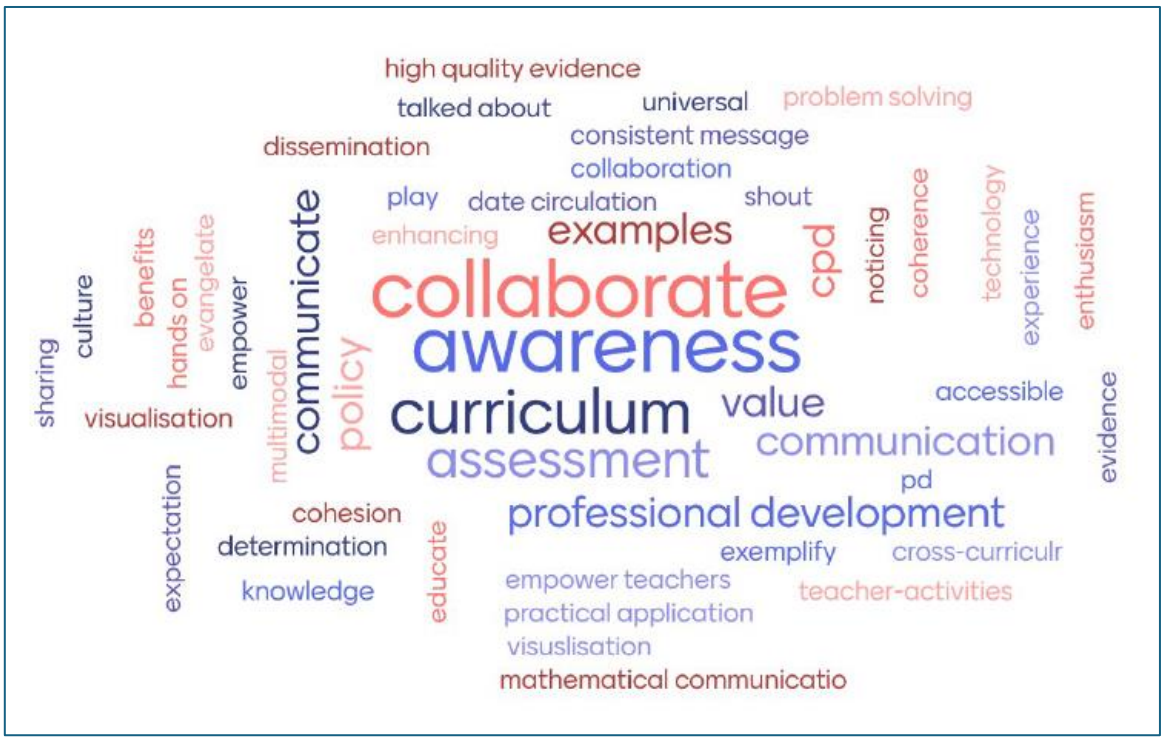
5) foster networks for collaboration and knowledge exchange

6) influence education policy and curriculum design.

There was shared recognition that spatial reasoning is an underdeveloped component of mathematical and wider learning, with potential to improve outcomes for all learners.

What do we need to make spatial reasoning a reality in education?

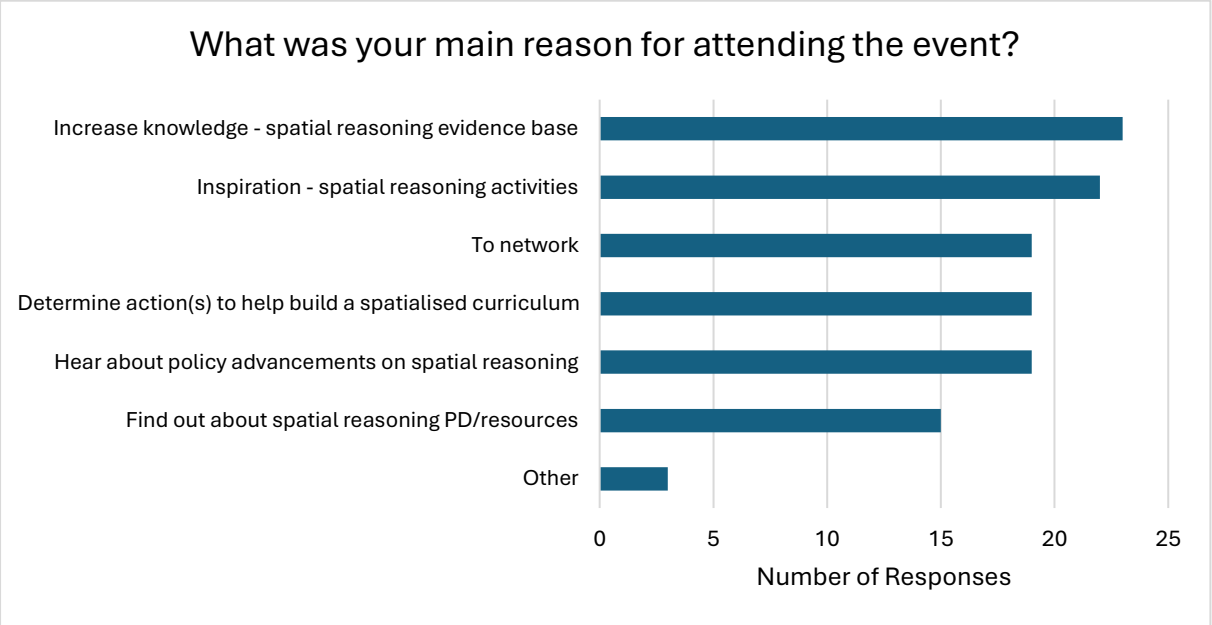
Attendees were asked the following live question: "*In one word, what do we need to make spatial reasoning a reality in education?*" Responses generated the following word cloud:



Event feedback

A feedback form was sent via email to the 54 attendees immediately after the event. Thirty-two responses were received, a response rate of 59%.

In addition to being asked about their planned actions (above), attendees were asked their reason(s) for attending the Make Space event. Responders were able to tick multiple reasons. As can be seen in the figure below, most responses were ticked by a large number of respondents, with "increasing knowledge" and "inspiration" the most chosen responses.



Attendees were asked to rate the statement "*I have learned something new from this event*" on a five point scale from strongly agree, to strongly disagree. There was an overwhelmingly positive response with 22 (69%) strongly agreeing to the statement and 10 (31%) agreeing to the statement.