This article originally featured in the Spring 2022 edition (Volume 26, Number 1) of Primary Mathematics by the Mathematical Association and is available here with their kind permission.

Spatial reasoning and STEAM

Emily K Farran, Alison Borthwick and Catherine Gripton

When we think of spatial reasoning in the early years we are probably drawn to thinking about shape and space. This is a natural and expected link. However, as we explore spatial reasoning further, we realise that it underpins so much more than just geometry and potentially provides the foundation for a range of careers. When trying to see who can build the biggest arch using the blocks, are children thinking like a mathematician, scientist, engineer, designer or architect?

In primary school, number lines require children to think about magnitude, proportion and scale. Drawing involves perspective and translating between 2D and 3D. Data visuals use perspective, direction and movement. Planning a route for a robot involves thinking about distance, direction, orientation and navigation. We can organise curriculum to strengthen connections between subjects or areas. This can support sense-making and engender an appreciation of human creativity and achievement (Barnes, 2011, Rose, 2009, Alexander, 2010). Primary STEAM (science, computing, technology, engineering and mathematics, with the recent inclusion of art and design) offers a coherent way of valuing these links between subjects.

Image published with permission from RM Resources

This article originally featured in the Spring 2022 edition (Volume 26, Number 1) of Primary Mathematics by the Mathematical Association and is available here with their kind permission.

Beyond primary school, spatial ability is important for the development of expertise in the spectrum of Science, Technology, Engineering and Mathematics (STEM). Expert knowledge of 3D anatomical structures and the spatial relationships between them is essential for decision making in medicine, for example. Neuroscientists use scans of the brain to determine the spatial location of neural activation or of lesions, whilst for chemists the spatial organisation of the periodic tables is used to represent the relationships among the elements (Atit et al., 2020). Geologists use spatial timelines to understand geologic time and use topographical maps to extract a 3D representation from 2D information. Architects, engineers and designers use computerised 3D models. Increased awareness of the spatial aspects of traditional STEM disciplines might enable universities and employers to better align the supply and demand of STEM graduates (Wakeham review, 2016). That is, STEM graduates are required for economic success, yet in the UK 70% of STEM companies report difficulties recruiting (Baker, 2018).

Primary STEM (science, computing, design and technology, mathematics) offers a coherent link between subjects and the advent of STEAM (including the arts) recognises the wider value of other subject areas. By improving spatial thinking skills from a young age, as outlined in the ECMG spatial reasoning guidance, practitioners can foster the strong spatial problem-solving skills involved in the full spectrum of STEAM subjects and positively impact later success in entering the work force in a wide variety of careers.

Alexander, R. (2010) *Children, their World, Their Education: Final report and recommendations of the Cambridge primary Review.* London: Routledge.

Atit, K., Uttal, D.H. & Stieff, M. Situating space: *using a discipline-focused lens to examine spatial thinking skills.* Cogn. Research 5, 19 (2020). ***https://doi.org/10.1186/s41235-020-00210-z***

Baker, Y. (2018). *STEM skills indicator findings.* Available at: ***https://www.stem.org.uk/sites/default/files/pages/downloads/stem-skills-indicator-findings.pdf***

Barnes, J. (2011) *Cross-curricular Learning (2nd edition).* London: Sage.

Rose, J. (2009) *Independent Review of the Primary Curriculum:* Final Report. London: DCSF.

Wakeham, W. (2016). *Wakeham review of STEM degree provision and graduate employability.* Available at: ***https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/518582/ind-16-6-wakeham-review-stem-graduate-employability.pdf***

Emily is Professor of Cognitive Development, School of Psychology, University of Surrey.

Alison is an international mathematics and education adviser and chair of the Joint Primary MA/ATM Group.

Catherine is Assistant Professor at the University of Nottingham.