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Putting it in Perspective

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developing perspective-taking in the primary classroom

The focus of this special issue of Primary Mathematics is on spatial thinking because of the growing evidence of its importance in mathematics and indications that it has significant potential for improving children's learning. As evident in the range of content in this issue, spatial thinking is a broad and varied area that functions as an umbrella term for a number of important spatial abilities. Whilst all areas of spatial thinking could be afforded greater emphasis in mathematics education, perspective-taking is arguably one of the most over-looked. In this article, I consider the case for perspective-taking and offer four simple activities to develop it in the primary classroom.

Defining perspective-taking

Perspective is about how things appear to us from where we are. Perspective-taking is a dynamic spatial skill as perspective changes as we move around, requiring 'a real or imagined shift of one's personal frame of reference' (Davis et al., 2014:19). It is sometimes referred to as 'self-to-object' or 'egocentric' spatial processing (Kozhevnikov et al., 2006) because it relates to how we see things and our persona viewpoint (real or imagined). Perspective-taking includes visibility, whether or how much can be seen from a specific perspective (whether it is hidden or partially hidden, for example) as well as how this changes as we move. It includes both what we can see from where we are and what we might be able to see from a different vantage point. To perceive something from a perspective other than our own, requires cognitive flexibility as we imagine moving to take up a different viewpoint. Whilst it sounds challenging, imagining an alternative perspective is more natural than one might think. This is supported by freedom to explore in childhood as this enables children to gain invaluable experience of the world from a wide range of perspectives.

For primary aged children, perspective-taking involves:

- **Visibility 'what we see'**
  Whether something can be seen, if it is hidden or partially hidden and perhaps appearing to overlap. This includes changes to these with movement and changes to perspective.

Can the child see all of the bicycle?

- **Appearance 'how we see it'**
  What things look like from different perspectives including from above, the side and the back as well as from near and far away. This includes how appearance changes with movement and changes of perspective.

Front

Back

Side

Far away

- **Viewpoints 'how someone else sees it'**
  What can be seen from an alternate viewpoint to the one you currently have. This involves imagining moving to a new position to take a different perspective.

What can the child see?

Perspective-taking is important in planning routes and navigating around our environment. It supports us to perceive and predict the shape and size of objects or landmarks, even when we can only see them partially, and to anticipate where we will be and how things will appear ahead of time. Being able to interpret different perspectives helps us to make sense of diagrams, models and maps which utilise specific perspectives to represent spatial relationships. The mental manipulation involved in taking an alternative perspective supports visualisation skills and works alongside mental rotation from approximately 6 years onwards to support children to visualise objects in alternative orientations and from different viewpoints (Cross et al., 2009). Mental rotation and perspective-taking combine to support navigational abilities but perspective-taking seems to be particularly important in wayfinding (Kozhevnikov et al., 2006). Perspective-taking skills vary considerably between individuals but can be taught and it seems that early childhood is a particularly important time for perspective-taking development.

The development of perspective-taking

Perspective-taking abilities begin developing early with young children enjoying games where things and people shift between being hidden and visible (such as peekaboo). As babies, they begin to follow the gaze of others. Children as young as 18 months demonstrate awareness of the importance of a clear line of sight and that obstacles can obstruct others from seeing what they can see (Flavell, 1999). By 2 years of age, some children can determine whether another person can see something or not from where they are (Moll & Tomasello, 2006). Perspective-taking develops alongside physical development. As children become more experienced at crawling and walking, their perspective-taking develops so locomotive experience seems more important than age in determining the development of early perspective-taking skills.

As early as 3 years, children can identify if they would see the front, side or back of a single objects (Ives, 1980). They find oblique (45°) views on maps and in photographs easier to interpret than from directly above, at least until around 5 years (Clements & Sarama, 2021). The ability to imagine what someone else can see also emerges at around 5 years then improves considerably by around 8 years (Frick et al. 2014) as children learn to suppress the influence of their current perspective in order to imagine someone else's. Having frames of reference *(e.g. a specific place to imagine yourself sitting)* is useful and children find it particularly helpful if there is a person, doll or toy animal to identify with. Children find it easier to take an alternative perspective if they imagine what the toy can see.

The table shows a simple developmental progression for early perspective-taking taken from the Early Childhood Mathematics Group's spatial reasoning trajectory (Gifford et al., 2021).

Approximate age	Children are learning to…
Babies	**Enjoy hiding** and finding with themselves and objects
Toddlers	**Explore familiar environments**, moving freely around and enjoying finding out about the world from the new viewpoints they experience
2 year olds	**Explore what can be seen and how things look** from different viewpoints, *e.g. partially hidden, looking between your legs or hanging upside down from a sofa*
3 year olds	**Perspective-take**, recognise objects that are near or far away.
4-5 year olds	**Explore what can be seen from different viewpoints**, *e.g. knows how to hide effectively from a 'seeker'*; compares what they can see *e.g. from the top and bottom of the climbing frame*.
6-7 year olds	Interpret and predict what and how things will appear from different viewpoints **(perspective–taking)**, including when partially obscured or from above (plan view).

Notwithstanding typical developmental progressions, there is significant variability between individuals in their perspective-taking skills and this is probably related to the range and amount of experiences they have of perspective-taking. For children who begin school with fewer experiences, opportunities to develop perspective-taking are particularly important for their ongoing and future spatial development. Perspective-taking can be

included in a range of mathematics lessons as well as in classroom routines. In the next section, I explore a few examples of primary classroom activities.

Perspective-taking activities for the classroom

Visibility

Guessing games where part of an object or image is hidden are popular classroom favourites. These can be as simple as hiding a numeral or shape card behind a cardboard barrier or under a cloth and revealing a small amount at a time. This can be replicated easily on a computer by dragging an opaque shape to reveal what is hidden behind. These games present opportunities for reasoning about what the hidden item can and cannot be and why, based upon the small amount revealed. It can be a lovely way to introduce a new book or artwork, beginning with it covered by several jigsaw pieces and removing one at a time (sometimes over several days), prompting children to visualise, discuss and draw what might be under the hidden sections based on what has already been revealed.

'Saint George and the Dragon' by Paolo Uccello (partially and fully revealed)

Appearance

Exploring how objects and landmarks appear from different viewpoints can prompt mental manipulation of perspective and interesting discussions as children make sense of unusual and intriguing shapes and arrangements presented by less familiar perspectives. Images such as building plans, diagrams from instruction manuals and aerial photographs can stimulate rich discussions about what you can and cannot determine from the image, which features help you to make sense of the image and why that perspective might be useful. Offering two photographs of the same model can provide two reference points from which to determine what the three dimensional model might look like. From this children can draw or even create the model, if they have identical materials (such as wooden or Lego® blocks). Similarly, encouraging children to record what they have built in block play or construction by drawing their building focuses their attention to the appearance of the shapes from a specific perspective. Teachers can encourage children to walk around what they have made, discussing how shapes appear different from a range of perspectives.

Viewpoints

Children find it easier to imagine what something looks like from an alternative perspective if there is another person, animal or character that the child

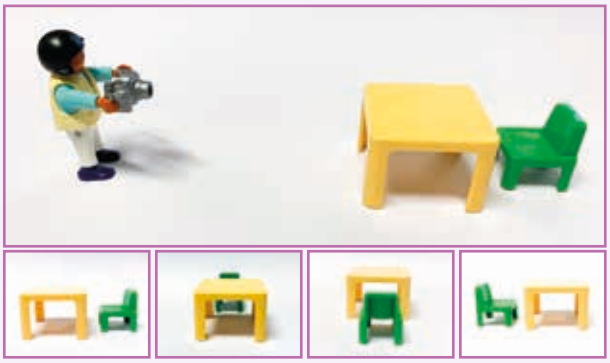
can identify with (as they form a sort of relationship with the character and can try to see things through their eyes). It can also be helpful if they have some frame or point of reference that can help them to perceive this new perspective. This might be the position of a chair in relation to the table helping them to imagine seeing the chair before the table in front of them or a specific object on a table to act as an anchor to perceiving the position of the other objects in relation to this. Choosing a child to perform a classroom task is an opportunity to develop perspective-taking by stating what they can see from where they are in the classroom rather than using their name. For example *"This person can see the back of a green jumper to the right and reading books to the left"*. This encourages children to decide if it is possible that it could be them or not based on where in the classroom the person must be. Showing footage from webcams (for example online nature cams or a webcam in the classroom) can also provide children with perspectives that they rarely get to see. Additionally, experience using programmable toys can also provide opportunities for taking an alternative perspective, deciding which way the toy needs to travel when facing in a different direction to you.

Activity 1

Draw part of a numeral or shape on a board/tablet and ask children to guess what number or shape you are drawing. What could it be? What can't it be? Why? Children can draw with their finger in the air what they think the number or shape might be encouraging visualisation of the hidden part. Revealing a little more can lead to children changing their mind. Offering children ludicrous suggestions can lead to interesting explanations about why that is simply not possible.

Activity 2

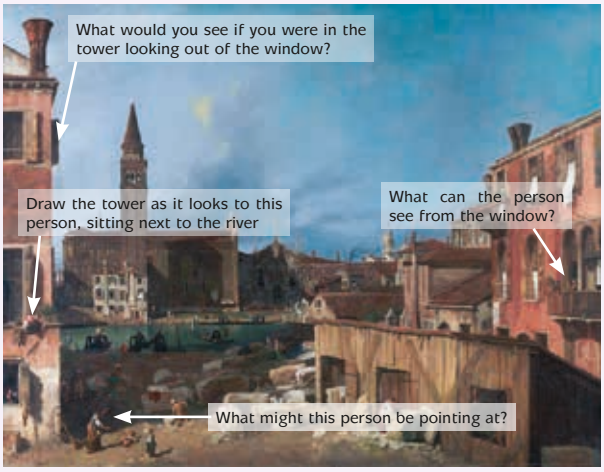
With several photographs of the same model or scene from different perspectives *(e.g. front, sides and back)*, ask children to identify which of the photographs shows what the person can see? This could be one person or several people where the photographed perspectives could be matched to each person. The models can be recreated so that children can move around to experience the perspectives for themselves to check their answers.



Which photograph did the child take? How do you know? Why can't it be photo 3? Frick et al. (2014)

Activity 3

Using a painting of a landscape or city from an art gallery's online collection, children can draw what can be seen from a specific perspective in the painting, perhaps from a specific place or through the eyes of a specific person depicted in the painting. This can lead to discussion about what can and can't be seen from that vantage point as well as how landmarks might appear to be a different shape from this perspective. Children might enjoy swapping pictures to work out the perspective that another child has captured in their drawing or they might be able to represent this alternative perspective using blocks, playdough or construction. Switching between two and three dimensional representations challenges thinking so drawing on whiteboards and representing in dough can be good to begin with as these can be adapted easily as children develop their ideas.



The Stonemason's Yard by Canaletto
(The National Gallery)

Activity 4

Hiding a toy such as a small teddy or figure in the classroom can be a way to encourage children to consider alternative perspectives. The teacher can describe what the toy can see from where they are or have a photograph ready from the toy's perspective so that the children use these to determine where they think the toy might be hiding. This can promote reasoning, where children consider possible and impossible locations based on the information that they have and can justify their answer to where the toy is hidden. Repeating this several times across a day or a week can provide the opportunity for improvement and children can begin to take responsibility for hiding the toy.

Clements, D. H., & Sarama, J. (2021). Learning and teaching early math: *The learning trajectories approach (3rd ed.)*. New York: Routledge.

Cross, C. T., Woods, T. A., & Schweingruber, H. E. (2009). *Mathematics learning in early childhood: Paths toward excellence and equity*. Washington DC: National Academies Press.

Davis, B. & the Spatial Reasoning Study Group (2015). *Spatial reasoning in the early years: Principles, assertions, and speculations:* Oxon: Routledge.

Flavell, J.H. (1999). Cognitive development: *Children's knowledge about the mind. Annual Review of Psychology,* 50(1), 21-45. doi:10.1146/annurev.psych.50.1.21

Frick, A., Möhring, W., & Newcombe, N. S. (2014). Picturing perspectives: *development of perspective-taking abilities in 4- to 8-year-olds*. Frontiers in Psychology, 5(386). doi:10.3389/fpsyg.2014.00386

Gifford, S., Gripton, C., Williams, H.J., Lancaster, A., Bates, K.E., Williams, A.Y., Gilligan-Lee, K.A., Borthwick, A. & Farran, E.K. (2021) *Spatial reasoning in early childhood: Research summaries and trajectory of early learning experiences to develop spatial reasoning.* doi:10.17605/OSF.IO/BX87U

Ives, W. (1980). *Preschool children's ability to coordinate spatial perspectives through language and pictures.* Child Dev. 51, 1303–1306. doi:10.2307/1129579

Kozhevnikov, M., Motes, M. A., Rasch, B., & Blajenkova, O. (2006). *Perspective-taking vs. mental rotation transformations and how they predict spatial navigation performance.* Applied Cognitive Psychology, 20(3), 397-417. doi:https://doi.org/10.1002/acp.1192

Moll, H. & Tomasello, M. (2006). Level 1 perspective-taking at 24 months of age. British *Journal of Developmental Psychology*, 24(3), 603-613. doi:10.1348/026151005X55370

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Three Way Mix Up

Jack has three blue tiles, three yellow tiles and three green tiles.

He put them together in a square so that no two tiles of the same colour were beside each other.

Can you find another way to do it?

Can you find ALL the ways to do it?

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