

Spatial cognition and biases in education

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There is a historical bias in education—in both elementary and secondary schools—that should be corrected, since curricula have not been developed with equal attention to the needs of girls and boys. This bias may be the source of many stereotypes (such as "math is for men"). It could be hindering girls' education, especially in technical subjects, which would influence their choice of STEM (Science, Technology, Engineering, Mathematics) majors when they reach college. Here, I discuss various approaches to addressing this issue, which still raises numerous questions.



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Some readings strike a chord with us and make us reflect. This is the case, for example, with the book by American oncologist Elizabeth Comen, All in Her Head (2024), which describes diagnostic errors in women across all areas of medicine due to ignorance of the female body and its specific characteristics. Let's keep in mind that, with the exception of issues related to the reproductive system and childbirth, the female body has traditionally been viewed as a flawed version of the male body, and very little research has been devoted to it. Today we know how flawed this approach is, as it has led, among other problems, to immeasurable suffering for women.

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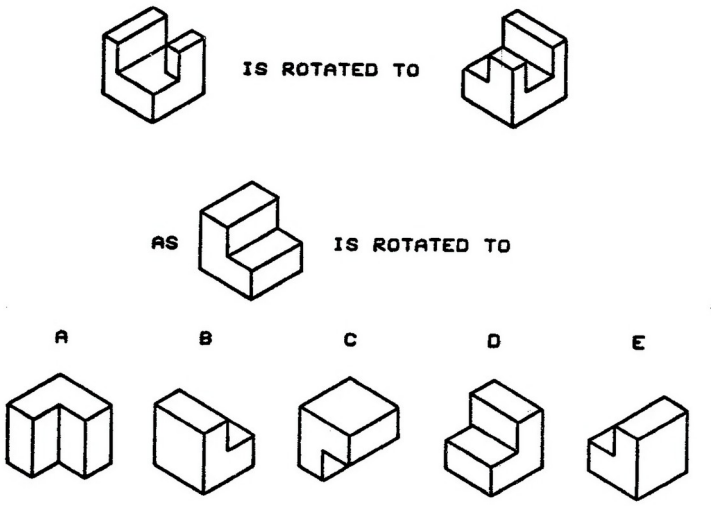


Figure 1. Purdue Spatial Visualization Test (Guay, 1976). In this figure, you must first observe how the object in the top row rotates. Then, looking at the object in the middle row, you must imagine what this object looks like when it rotates in the same way as the one in the top row. Finally, looking at the bottom row, you must choose one of the five objects shown. The solution is drawing D.

Just as in the field of health, formal education has always been approached from a male-centered perspective—that is, with a focus on the needs of boys—since it was traditionally reserved for males, while girls and women were relegated to the domestic sphere. This could explain the emphasis in the school curriculum on verbal and linguistic skills, in which boys perform worse than girls (Reily, 2023), with the result that girls have to keep working on material they have already mastered, without anyone ever questioning whether they are being made to waste their time. Could this overlearning of verbal and linguistic skills be responsible for girls learning to solve other problems—such as certain spatial tasks—using a verbal strategy? (see Saucier et al., 2003; Johnson & Bouchard, 2007).

What changes should be made to the school curriculum with girls in mind? A wealth of data points to the importance of combating stereotypes (Chamizo, 2025a), as well as researching the specific characteristics of girls from early childhood onward (Chamizo, 2025b) and strengthening their spatial abilities (Wai et al., 2009). These skills are crucial in all STEM disciplines. Specifically, in physics, engineering, and computer science—at least in Western countries—there is a gender gap that disadvantages girls and is difficult to explain.

Spatial abilities represent a broad and highly varied set of cognitive skills within the spatial domain. Consider, for example, the ability to create orthogonal projections of objects—that is, to imagine a three-dimensional object based on two-dimensional information. When this is the case, the person is said to have good spatial visualization, which is the ability to mentally represent and manipulate objects in three dimensions—for example, by mentally rotating them, breaking them down into various parts, and recombining these parts into a new pattern or object (see Figure 1 for an example). Another very different way to approach spatial abilities is through tests known as spatial orientation or navigation tests, which measure individuals' ability to navigate their environment (Mackintosh, 2011). These skills are malleable (Uttal et al., 2013), even though they were long believed to be innate and immutable. In both types of tests, at least in Western countries, boys outperform girls.

Fortunately, there are specific training programs—often in the form of games or video games—that can help reduce this imbalance between boys and girls (see Prieto-Rodríguez et al., 2020, for a review of STEM initiatives; Wang et al., 2022, for a meta-analysis of digital video games). But are teachers sufficiently prepared? Various authors argue that they are not and that this is where the main problem lies, starting in elementary school (Martinot et al., 2025). In short, if we are committed to equitable education, I believe that the school curriculum should address spatial skills just as much as verbal and linguistic skills, to benefit both boys and girls equally. Collective reflection and a broad debate are necessary to correct a historical bias in education that could be seriously harming girls by ignoring their needs. This requires not only acknowledgment of the facts but also a swift solution.

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