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Learning to Think Spatially Through Curricula That Embed Spatial Training

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Tweet: Middle school students' spatial thinking can be improved while they learn astronomy.

Audience: Formal educators; Curricula developers

Key Points

- Spatial skill is a strong predictor of students' performance in STEM education, and different types of spatial skill are associated with different topics in STEM.
- Perspective taking (PT) skill describes one's ability to imagine objects from different perspectives and make sense of them.
- Students who learned seasons and lunar phases with the *ThinkSpace* curricula demonstrated improvement in their PT skill and increased the frequency with which they applied PT when explaining astronomical phenomena.
- Students with higher initial PT skill or who made greater gains in PT skill were more likely to make greater improvements in astronomy understanding, highlighting the importance of PT skill in astronomy.
- The *ThinkSpace* curricula can be accessed at wwtambassadors.org/seasons and wwtambassadors.org/moon-phases

INTRODUCTION Strong spatial skills are foundational in predicting students' performance in science, technology, engineering and mathematics (STEM) education. However, few studies have examined the factors that influence improvement in students' spatial thinking during school science curricula. This study investigated the *ThinkSpace* curricula — two middle school astronomy units designed to support students' ability to apply the spatial skill of perspective taking (PT) while learning to explain lunar phases and the seasons. *ThinkSpace* was designed to support students' spatial thinking by focusing on their use of PT skill in navigating Earth- and space-based perspectives; the curricula were designed to give students opportunities to exercise their PT skill in ways that facilitated their construction of explanations about astronomical phenomena. We integrated dynamic visualizations with hands-on modeling, an approach represented in few studies of these phenomena. Pre- and post-instruction multiple-choice content assessments, perspective-taking skill assessments, and interviews were gathered from students in 6th grade and 8th grade classrooms across four urban and suburban school districts.

FINDINGS We found an overall improvement in students' PT skill across both *ThinkSpace* curricula. We also found that higher initial PT skill and higher gain in PT skill predicted greater improvement in students' astronomy understanding, even when accounting for their initial content knowledge. Further, across all initial PT skill levels, students used perspective taking significantly more frequently when explaining astronomical phenomena, suggesting students developed a greater understanding of how to apply their PT skill when explaining spatial problems during the curriculum. These findings have compelling implications. First, when students make gains in their PT skill and content knowledge, they have a stronger foundation to support future learning of other STEM disciplines. Second, these findings suggest that middle school students can improve their spatial skills without separate, generic training in those skills, outside of the context of the discipline. And while all groups in the study showed gains in PT skill and conceptual understanding, we saw some differences in the amount of gain across groups that may be associated with student gender and district socio-economic status, which warrants further study.

TAKEAWAYS This study contributes to our understanding of the important role spatial skills play in student achievement in science. Students with higher initial spatial skills and who made greater gains in spatial skills improved more in their understanding of astronomy. The gains students made in their spatial skills during the curricula lead us to recommend more focus on designing curricula that engage students in spatial skills practice, embedded in learning science disciplines, as a form of spatial training.