How do students learn spatial thinking through sensemaking practices?

Abha Vaishampayan1; Julia Plummer1; Patricia Udomprasert2; Susan Sunbury3
1The Pennsylvania State University, 2Harvard University, 3Smithsonian Astrophysical Observatory

RESEARCH PROBLEM
• Spatial thinking is an important predictor of students’ success in STEM education (Uttal et al., 2013)
• There is limited research on:
  • how K-12 students learn spatial thinking
  • which practices might improve students’ spatial thinking
  • how to facilitate students’ engagement in spatial sensemaking practices

OUR STUDY
• Investigation of students’ use of spatial sensemaking practices through a spatially-enriched seasons and lunar phases curriculum
• Focus on students’ use of perspective-taking skill (PT skill) – how a scene might look like to an observer from a different perspective or a different line-of-sight (Liben & Downs, 1993)

CONCEPTUAL FRAMEWORK: SPATIAL SENSEMAKING PRACTICES
Spatial sensemaking practices are used to interpret and communicate spatial information (Ramey & Uttal, 2017)

RESEARCH QUESTION
How might a spatially-enriched curriculum engage students in spatial sensemaking practice?

METHODS

Setting & subjects
6th grade classrooms, N=185 (11-12-yr old)

Curriculum
10-day ThinkSpace curriculum on Seasons and Lunar Phases

Data
Classroom videos (total of 900 min of data)

DATA ANALYSIS
• Interaction Analysis (Jordan & Henderson, 1995) – analysis of students’ gestures, their use of materials and tools from the learning environment, and observable actions and interactions with their peers & teacher.
• Coding: Deductive approach to pattern coding – classroom instruction was broken down into units of analysis called PT sensemaking episodes, which showed students’ use of spatial sensemaking practices.
• Validity: Established inter-rater reliability calculating Cohen’s Kappa for each spatial sensemaking practice and the type of perspective (gestures (0.616), obj. manipulation (0.767), sketching (0.750), use of fixed artifacts for referencing (0.5), type of perspective (0.645)

FINDINGS – Patterns in Use of Spatial Sensemaking Practices

Teacher’s PT questions, along with the use of object manipulation, was most productive in eliciting students’ connections between multiple perspectives

The practice of sketching was useful for visualizing space-based perspective

Use of fixed artifacts may have created an immersive experience for students to visualize different perspectives by fixing their reference point

DISCUSSION – Learning through embodied cognition (Wilson, 2002)

We offload cognitive work onto the environment – Using physical and virtual models created ways for students to concretize their mental visualization in physical entities and supported their perspective-taking

Embodied actions can manifest in social interactions – The teacher’s prompts about gesturing, sketching, and using objects elicited students’ use of perspective taking

Offline cognition is body-based – Gestures and bodily actions were useful when simulating processes that are removed from the context such as replicating the moon’s cycle using their body or using hand gestures for showing earth-based view of the sun’s path

Implications: The findings suggest that intentional use of questions to elicit students’ PT skill, providing them appropriate materials that support externalization of their mental visualization, and using a variety of resources in combination instead of in isolation might support students’ use of PT skill in different ways for studying astronomical phenomena.

REFERENCES

CONTACT
Abha Vaishampayan
The Pennsylvania State University
abv5104@psu.edu
Original manuscript: tnyurl.com/xyv8e8by

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