Physics students learning about abstract mathematical tools while engaging with “invisible” phenomena

Purpose

Goal – teach a key disciplinary affordance of coordinate systems, their movability.
Problem – appears fixed in most textbooks.

Framing of work

A multimodal social semiotic framing – various forms of representation required.

Semiotic resources (e.g. spoken & written language, algebra, graphs, diagrams, apparatus) cf. students' proficiency with using these (representational competence).

IOLab - mediating tool

Multi-purpose educational measurement instrument.
Hand held + real-time display of components of Earth's magnetic field – a phenomenon not accessible through the sensory modes.
A device with high pedagogical affordance.

Method & Analysis

Study with Swedish upper secondary students, working in pairs on open-ended task in laboratory setting.
Task: to find the direction of the Earth’s magnetic field in the room.

Video recording of students' engagement and use of making meaning resources.
Multimodal transcription – synchronous and asynchronous resource usage in video data carefully preserved.

Results

Learning sequence as predicted by social semiotic framework occurred demonstrating importance of a persistent resource acting as a coordinating hub for other non-persistent resources.

At first the students learned how to coordinate the range of resources and discover their meaning – the unique pedagogical affordances of the IOLab played a crucial role here.

Discussion & Suggestions

Study provided empirical evidence for students experiencing holding a movable coordinate system, and gaining insights into properties of the Earth’s magnetic field (e.g. “what the field looks like” around the globe).

Further; theoretically, data supports earlier findings (e.g. students require a critical constellation of resources to discern new disciplinary content).

Suggestions:

1. Potential for learning can be maximized around the use of a specific set of resources, and how they may be coordinated.
2. Teachers should be looking for coherent introduction of previously unused resources, as indicative of learning taking place.
3. Close attention should be given to the roles played by different resources; therefore to understand these, this study suggests further research in this area.