CARDS: A Mixed-REality System for Collaborative Learning at School. Giraudeau, et al. ISS. 2019.

What are the core research questions addressed by the work?

- How may tangible and mixed-reality approaches serve the purpose of education, especially by promoting knowledge sharing, construction of concepts, and facilitation of social relationships?

What motivates the work?

- For activities that either involve practical work or engage multiple participants, ubiquitous approaches that take place in three-dimensional space and foster spatial interactions and expressive representations seem to have good potential, particularly in the domain of education
- Concrete implementations using tangible interaction and augmented reality applications are rare in school
- Computer applications follow a WIMP design is not suited to interactive and collaborative learning activities

How does the work understand the usage, capabilities, and limitations of paper?

- High availability
- Facilitates collaborative work
- Tangible
- Physical learning interactions are less abstract, reducing extrinsic cognitive load & facilitate more intuitive learning
- Manual activities promote active engagement

What is the target application domain of the work?

- Education
    - Information sorting
    - Mind-map building

What are some proposed extensions to paper proposed by the work?

- Enable users to physically manipulate projected media as it could be done with physical ones. Supported media can be texts, images, sounds, or video (Physical-virtual association)
- Support mechanisms for managing the organization of documents within the workspace
- Support mechanisms for editing and viewing virtual documents

What design constraints or objectives guided the work's implementation of the proposed extensions?

- Listed pedagogical requirements:
    - Realistic environments & support for paper resources
    - Engaging interface compatible w. many levels of learner
    - Support two learning objectives: Learning to process information individually/collaboratively, engage in constructive dialogue in a collaborative setting
    - Open manipulation of physical documents & controls
    - Sorting and storage

How are the proposed extensions implemented?

- Projection-based augmented reality approach: Using a video-projector, a webcam, an interactive pen, and a computer
- Use of paper slips as physical proxies for digital elements that can be freely manipulated in the environment allowing grouping, organizing, and selecting information based on the inherent capacity of the system to spatialize items

What are the results of the work? What are the implications of the results for future designs and implementations of paper-based technologies?

- The greatest advantage of hybrid interfaces lies in their ability to copy real interactions and simplify the entry into the task
- There are still technological limitations, and hence copying the interactions exactly creates a situation where users initiate unstable state that disturbs the immersion of the system
    - Technological limitations have to be acknowledged and addressed through interaction