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Inductive Reasoning Challenges in Virtual Reality: A Case Study on Designing Submarine Models

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ABSTRACT

Inductive reasoning is crucial in engineering education, enabling learners to generalize principles from specific observations. This study examines the potential for inductive processes to facilitate knowledge transfer from sketching 3D shapes on paper to modeling in a 3D space using virtual reality (VR). The study involved undergraduate students designing submarine models and testing them in a digital underwater environment, using an advanced, custom-built VR application called "Submarine Simulator." The study consisted of two phases. In Phase 1, students were introduced to the application, gaining an understanding of the user interface and learning how to construct and test submarine models, laying the groundwork for their foundational knowledge. In Phase 2, participants began by sketching submarine models on paper before transitioning to the VR environment, where they designed and tested models to navigate both tight and loose spiral trajectories. This design was crafted to foster inductive reasoning, leveraging insights from sketching to develop hypotheses about hydrodynamic principles for VR prototypes. Results reveal no evidence of inductive inference during the sketching-to-VR transition, as assessed through design iterations and post-experiment surveys. Students did not generalize rules from sketches to improve VR outcomes, such as motor placement and weight distribution to influence trajectories. The paper presents qualitative metrics on reasoning efficacy and cognitive outcomes. This research advances literature on inductive reasoning by highlighting challenges in integrating analog and digital modalities through VR tools, such as the "Submarine Simulator," thereby informing refinements in STEM pedagogy.

Keywords: 3D modelling; engineering education; human-computer interaction; immersive technologies; simulation