NEWSLETTER

Does Virtual Reality Help Reduce Learners' Cognitive Load? A Meta-Analysis Based on 23 Experimental and Quasi-Experimental Studies

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AS educational technology advances, virtual reality (VR) has garnered widespread attention in academia. Extensive empirical research has been undertaken on the effect of VR on cognitive load, despite no consistent conclusion having been reached. This article is a meta-analysis of 23 empirical studies, seeking to examine the impact of VR on cognitive load moderated by variables such as the discipline, education phase, and intervention duration. Analysis results include:

- Overall, VR has a moderate mitigation effect on cognitive load.
- There is no disciplinary difference in the effect of VR on cognitive load. The effect remains undetermined in the fields of medical education, natural science, and humanities.
- The impact of VR on cognitive load remains basically constant in different intervention durations.
- The higher the frequency of intervention, the weaker the impact of VR.
- VR exhibits a significant mitigation effect on cognitive load under the task-driven teaching approach.
- There is no prominent difference in the effects of differential types of VR, such as immersive VR and desktop VR, on cognitive load.
- VR contributes to alleviating cognitive load in all application scenarios, with the most significant effect occurring in manipulative learning, followed by that in social and observational learning.

Based on the research findings, discussions are focused on the following aspects:

i. VR facilitates learners processing information through multiple channels of senses, so expanding the restricted work memory capacities and lowering cognitive load.

ii. VR poses the most significant effect on cognitive load in engineering disciplines, which requires visualized learning scenarios to support students' hands-on manipulation and grasp of learning content. VR has the potential to make abstract concepts more concrete, encourage autono-

mous inquiry and repetition of exercises in learners, thus reducing cognitive load.

iii. Regarding the intervention duration and frequency, VR can most effectively mitigate cognitive load when the application time is less than 30 minutes or when it is adopted in one single application. That is because the memory and metabolism of the hippocampus will be enhanced due to the novelty effect of VR, activating cognitive patterns and maximizing their use, and as a result, alleviating cognitive load.

iv. Task-driven teaching approaches emphasize learning through doing and the importance of the agency of students in learning. VR allows students a mixed scenario that combines virtual and real worlds, encouraging active exploration and problem solving in them. That assists in student knowledge construction and reducing cognitive load.

v. The type of VR technology has little effect on VR's impact on cognitive load. This finding may be due to the incomplete data and the high receptivity of technology on the part of the subjects in the experiments.

vi. VR is more advantageous in manipulative learning settings because VR-assisted simulation environments may facilitate students' mastery of abstract concepts as well as supporting their repeated manipulation and timely acquisition of feedback, thus promoting personalized learning that helps lower cognitive load.

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