VIRTUAL REALITY TO ENHANCE ENGAGEMENT & LEARNING IN BIOCHEMISTRY

Metabolism in the Metaverse

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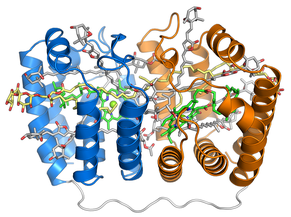
COLUMBIA | SOLER
Science of Learning Research Initiative

EMERGING TECHNOLOGIES



Background

- **Fall 2020.** Professor's Stockwell's first exploration of virtual reality (VR) for teaching introductory biochemistry (GU4501); compared learning outcomes and attitudes of students who participated in small group recitation sessions in either a VR platform or Zoom.
- **Summer 2021.** Second iteration with new tools: lighter, more powerful Oculus Quest 2 headsets and a superior VR platform, Glue; preliminary evidence that VR experience enhances student learning and strong evidence that it is more engaging for students than Zoom.
- **Fall 2021.** Third iteration with key modifications.
  - **VR condition was compared to in-person, rather than Zoom-based, recitation section** – with return to in-person instruction now possible, it is crucial to evaluate efficacy of VR experiences relative to appropriate "default" setting.
  - Instead of a single VR recitation section led by Professor Stockwell, **two separate VR recitation sections with each led by a teaching assistant trained in VR instruction**.
  - **Hypothesis: student survey responses and performance on assessments will reveal advantages of VR relative to in-person.**

Method (Fall 2021)

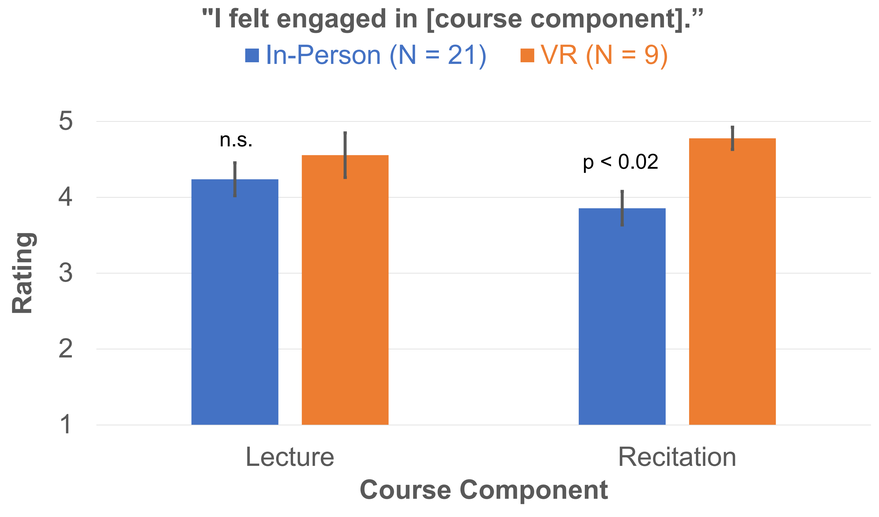
- Two weekly course components: in-person lecture session and small-group recitation section.
- **All students (78 total) attended in-person lecture together; each student chose to enroll in either VR or in-person recitation.**
- Each recitation section included ~10 students and was led by a TA. Both formats featured discussion of learning objectives, visual representations of course content (e.g., proteins, pathways), small-group work, and opportunities for student questions. In VR sections, students interacted with 3D models of biochemical objects that could be moved, rotated, and scaled – the screen capture on right shows the VR environment, student avatars, and a protein model. In in-person sections, 2D images of similar models were displayed on slides.
- At end of semester, students who consented to participate in the study (enrolled per IRB-approved protocol) were asked to complete two tasks: (1) **a brief multiple-choice quiz that addressed learning objectives related to 3D, spatial understanding of course material**, and (2) **a survey in which students reported subjective feelings on dimensions such as engagement, motivation, and confidence vis-à-vis the course**.

Results

- 9 students in VR group and 21 students in in-person group completed the study requirements.
- **Groups performed similarly on the 3D/spatial learning objective quiz.**
- Of the subjective dimensions included in the survey, only Engagement revealed an inter-group difference: the two groups rated their agreement (on a Likert scale of 1 to 5, with 5 representing strongest agreement) with the statement "In my Biochemistry [course component], I felt engaged" similarly for the lecture component (which was the same session for all students), whereas the **VR group rated the Engagement statement higher than did the in-person group for the recitation component** ($p < 0.02$; see figure at lower right).

Discussion

- **Learning outcomes.** Though our previous work indicated that VR could enhance learning, the present study did not provide evidence of such an advantage with respect to student performance on the multiple-choice quiz. Two possible factors may account for this difference: (1) technical issues with Glue forced the cancellation of some VR meetings and prevented the use of some 3D models – the strength of the VR "treatment" was thus diluted; and (2) in-person instruction is likely more effective than Zoom, so the differential between learning in-person vs. VR is presumably smaller than Zoom vs. VR.
- **Subjective responses and (non-)randomization.** Because the VR and in-person groups rated their engagement during the (in-person) lecture component of the course similarly, it is reasonable to conclude that the VR group's higher ratings on the recitation component relative to the in-person group reflect a meaningful difference in student experience, i.e., students did indeed find VR recitations more engaging than in-person recitations. However, students were allowed to choose which recitation format to enroll in rather than being randomly assigned to one or the other. We should thus be cautious about attributing the difference in engagement ratings to the effect of the recitation format itself; it could be that a self-selection bias was in effect such that students' preferences and expectations about the recitation formats explain both their choice of enrollment and their survey responses. Accordingly, we will prioritize random assignment (despite the inherent scheduling difficulties) in future iterations of the study.
- **Study enrollment and attrition.** Only 11 of 20 (55%) of students in the VR recitations consented to take the quiz and survey and, of these, 9 (82%) completed those forms; similarly, only 31 of 58 (53%) of the students in the in-person recitations consented and 21 (68%) completed. Increasing study enrollment and follow-through is another priority for future project iterations to ensure robust, reliable data.



Engagement ratings by course component and recitation format. Error bars represent +/- SEM.

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