

**Table 1.** Overview of Variables and Instruments.

Variable	Description	Assessment
Individual differences: - Gender and demographics - Technology enjoyment - Spatial Abilities - Expectation	Individual differences to discern student participants and provide both insights into the comparability of the two groups (GO and Vive) and allow for potentially identifying groups that benefit most from immersive experiences.	Basic questionnaire on demographics. Two technology enjoyment questions: (a) I enjoy using technology. (b) I enjoy playing video games. The official Santa Barbara Sense of Direction Scale (SBSOD). Question on expectation: - What best describes your feelings about experiencing the virtual field trip to the Reedsville/Bald Eagle formations? Example questions: (a) I can learn the same amount from a virtual field trip as I can from an actual field trip. (b) Virtual field trips can replace actual field trips.
Opinion on the virtual field trip	Using a pre- post-design allows for assessing the opinions and attitudes toward iVFTs.	
Learning experience: - Subjective assessments - Lab grades	Learning experience has two components. The first is the self-assessed learning experience of students. The second is the grade students received on the lab assignment.	Question on learning: - I learned a lot from the virtual field trip Lab grades
Enjoyment: Field trip enjoyment Also, technology enjoyment discussed in <i>individual differences</i>	Enjoyment can be an essential aspect of a learning experience and might positively influence engagement with the material and students' intrinsic motivation.	Combination of three questions that address different aspects of enjoyment related to the immersive field trip experience: (a) I enjoyed using the virtual field trip. (b) I learned a lot from the virtual field trip. (c) given the possibility, I would do the virtual field trip again.
Media effects: Spatial situation model (SSM) Self-location	Media effects researches have curated substantial questionnaires to address questions of how present someone feels during exposure to a mediated location. We were particularly interested in a comparison of immersive virtual field trip using the Vive and GO.	We selected a subset of questions from the published and well-cited presence questionnaire (MEQ-SPQ) that measured the two levels of developing spatial presence through experiences in the virtual field site (two-level model; see [3] for more details). 1st level: SSM - example questions: (a) Even now, I could still draw a plan of the spatial environment I observed. (b) I was able to make a good estimate of the size of the spatial environment. 2nd level: Self-location example questions: (a) I felt like I was actually there in the environment. (b) I had the feeling that I was in the middle of the action rather than merely observing.
Simulator sickness	Simulator sickness (e.g., nausea, disorientation) is typically experienced by users who wear VR headsets for extended periods of time. Its level of severity is often varied with individual differences, virtual activities, and types of VR system. Severe simulator sickness might draw users' attention from the virtual field trip, decrease their involvement in the virtual field site, and therefore reduce their enjoyment and learning performance.	The standard Simulator Sickness Questionnaire (SSQ; [2]): A self-report symptom checklist assessing 16 symptoms that are associated with simulator sickness.
System usability	The evaluation of usability in VR systems is important for identifying and subsequently improving the user interface. It is also necessary to recognize the system features that were more or less essential for field trip experiences.	We modified a subset of questions from the well-cited usability questionnaire (VRUSE; [1]) that measured the usability of a VR system according to the attitude and perception of its users. The key usability factors of VR systems including <i>ease of use</i> , <i>interactivity</i> , and <i>display quality</i> were evaluated in the current study. Four questions: (a) What did you like best about your virtual field trip to the Reedsville/Bald Eagle formations? (b) What did you like least about your virtual field trip to the Reedsville/Bald Eagle formations? (c) What benefits do you think there are from using actual virtual field trips instead of virtual actual field trips? (d) What would you change about your virtual field trip experience to enhance it for future students?
Open ended feedback	As a new medium for delivering class content, immersive experiences are new to most students as well as to researchers. Open ended questions were included to elicit flexible feedback on aspects of the learning experience not covered in questionnaires and to guide future developments.	

*Note.* Lab grades were rated 0-25. Other variables were scored on a 5-point Likert scale or calculated by averaging the scores of several questions.

## References

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