**VR products and projects**

(Students, collaboration, statistical focus.) This paper presents a methodology for tracing shared view in 3D, multiplayer, headsets and tablets [Developing an In-Application Shared View Metric to Capture Collaborative Learning in a Multi-Platform Astronomy Simulation (acm.org)](https://dl.acm.org/doi/pdf/10.1145/3448139.3448156). A cross-technology simulation platform was created for collaborative night sky exploration, combining VR (Oculus Quest headsets) and tablets (Microsoft Surfaces) using Unity. Participants were divided into nine groups, each assigned to investigate a crash site in a 3D astronomy simulation. The simulation utilized Microsoft Surface Tablets and Oculus Quest headsets. Students received a worksheet with tasks and relevant information. Before the simulation, they received a brief explanation of controls and completed a pre-test. Afterward, a post-test gathered feedback on device usage, simulation experience, task difficulty, and collaboration.

The literature suggests that increased eye-gaze reoccurrence enhances collaboration and learning. This preliminary study explores the connection between Shared View (SV), tool use, and collaboration quality. SV is adaptable for various devices and screen ratios. Future research aims to validate the metric with a larger, more diverse sample, examining factors like demographics and group dynamics. This will help assess data bias, collaboration quality, and metric validity on a broader scale. The metric could enable just-in-time instruction and help educators when students face technology challenges. This method is proposed as an alternative to eye-gaze tracking in similar 3D multi-device simulation contexts. Tracing Shared View in 3D looks at how a group of users collectively interact with a shared 3D environment, considering their overall positions and interactions within that space. While Eye-Gaze Tracking concentrates on the gaze and attention of an individual user within a given scene, providing detailed insights into where they are looking.

(Less rigorous, but adapted in classes) San Diego’s group discusses efforts to integrate Virtual Reality (VR) activities into introductory astronomy courses and labs. The study focuses on two complex 3D concepts: Moon phases and stellar parallax. For Moon phases, a VR simulation was developed using the Universe Sandbox platform, enabling students to explore lunar phases and eclipses from various viewpoints. Testing involving a large cohort of astronomy students revealed that VR-based methods were *only* comparably effective to traditional teaching. Additionally, collaboration with a student-run VR Club led to the creation of a stellar parallax VR activity, enhancing students' understanding. The statistics is not provided.
Equipment: 360º cameras, head-mounted displays (HMDs), a VR backpack, and Google Cardboards.[vital-faculty-handout-2023.pdf (sdsu.edu)](https://its.sdsu.edu/classrooms/vital-faculty-handout-2023.pdf)
[From Virtual Reality club to a Career | New Student and Parent Programs | Student Affairs | SDSU](https://nspp.sdsu.edu/aztec-parents-program/news-aztec-parents/2021-nap/virtual-reality-club-career-sp2021)

**Limitations of Traditional Astronomy Education, VR's Advantages.**

VR in astronomy education overcomes several limitations of traditional approaches to teaching. VR environments are free from light pollution, ensuring clear views of celestial objects, and they are not weather-dependent, providing consistent learning experiences regardless of outdoor conditions.It brings high-resolution, realistic depictions of cosmic phenomena, helping students understand vast scales and distances. Complex concepts like tides become clearer in VR. VR engages students in an immersive and interactive learning environment.

**Limitations of Compatibility in VR.**

It is worthwhile to employ existing trustworthy accurate 3D simulations. Replicability of available VR simulations depends on several factors: VR platforms used, development frameworks, and software design. VR platform the headsets belongs to (Oculus, HTC Vive, PlayStation VR, Windows Mixed Reality). For example, in [Virtual reality simulation of a supermassive black hole | ScienceDaily](https://www.sciencedaily.com/releases/2018/11/181119064137.htm) obtained 360◦ Virtual Reality movies and a medium through which is possible to interactively communicate black hole physics (as an example calculated images based on recent best-fit models of observations of Sagittarius A\*). All relativistic and general-relativistic effects, such as Doppler boosting and gravitational redshift, as well as geometrical effects due to the local gravitational field and the observer’s changing position and state of motion, are therefore calculated self-consistently. The used methods and equipment:

~Conclusion:

VR simulations may be useful for introductory in class activities, such as work with constellations (making use of eye-tracking) in night sky and understanding complex astrophysical processes (black holes research paper). The mentioned works explored the applicability of VR in these two possible directions. <https://arxiv.org/pdf/2109.01592.pdf>

1) Stellarium:, open-source 3D planetarium software with a vast object database.

2) Engineering collaborators, compatibility

[Exploring the Frontiers of Space in 3D: Immersive Virtual Reality for Astronomy Outreach. - University of Georgia (exlibrisgroup.com)](https://galileo-uga.primo.exlibrisgroup.com/discovery/openurl?institution=01GALI_UGA&vid=01GALI_UGA:UGA&date=20221001&aulast=Impey&issue=31&isbn=&spage=28&title=Communicating%20Astronomy%20with%20the%20Public%20Journal&atitle=Exploring%20the%20Frontiers%20of%20Space%20in%203D:%20Immersive%20Virtual%20Reality%20for%20Astronomy%20Outreach.&sid=EBSCO:Academic%20Search%20Complete:160806683&volume=&pages=28-36&issn=19965621&au=Impey,%20Chris&epage=&genre=article) is it available?

[Exploring and interrogating astrophysical data in virtual reality - ScienceDirect](https://www.sciencedirect.com/science/article/pii/S2213133721000561#b1)