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Enhancing Astronomy Education: Demonstrating Astronomical Phenomena using Immersive 3D Learning Experiences

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Motivation:

Current astronomy resources are limited:

- 2D Illustrations of fundamentally 3D phenomena are not adequate.
- Visualization issues lead to misconceptions (e.g., Engstrom 1991).
- Blackboards, handouts, etc. cannot accurately capture astronomical scales.
- Celestial sphere difficult to accurately portray in 2D.
- Partial illumination of spherical bodies is impossible to draw on a board.

Figure 1: Screenshots of the Moon from the Star Chart VR application. Taken from different angles to illustrate the impact of location and shape on the witnessed illumination.

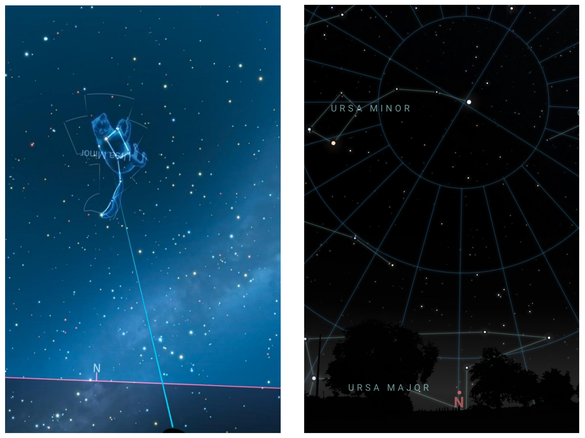
Example AR Simulation:

Figure 2: Image taken from sample AR simulation, to see this simulation in use scan the QR code. AR simulation developed by project team member Shameer Abdeen.

Limitations of Existing 3D Options:

Currently the availability of 3D astronomy software is limited, with few open-source options or resources that have been tailored for use in an undergraduate setting.

- Stellarium™: Main shortfall is the lack of projection to 3D hardware such as VR headsets.
- Universe Sandbox™ and SpaceEngine™: Not accessible in a classroom setting due to reliance on high quality graphics cards and requires commercial licensing.
- Star Chart™ : Omits astronomically significant details like the celestial sphere and requires commercial licensing.



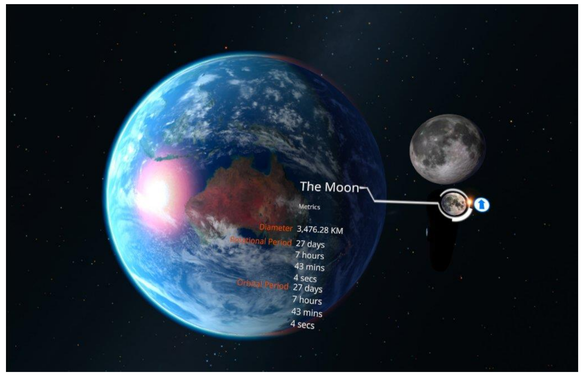


Figure 3: Sample images from Stellarium™ (top right) and Star Chart™ (top left and bottom). Top images show northern night sky from Athens GA. Bottom image shows partial illumination of the Earth.

Initial Phase:

The initial phase involves two commercially available 3D astronomy applications, SciVR and Star Chart.

- Use Star Chart™ to determine the efficacy of commercially available astronomy VR software.
- Use SciVR's (Kersting et al.) Solicit feedback on 3D tools in two different methods: 'Smart Window' and VR.

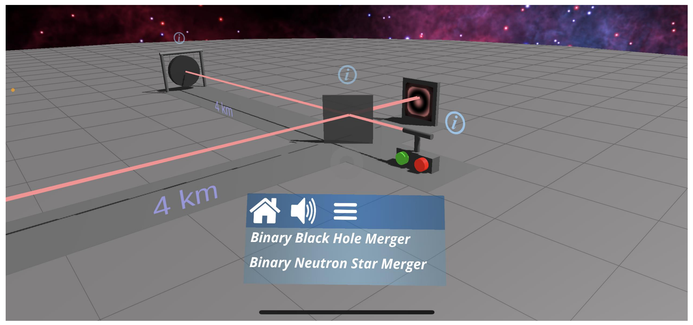


Figure 3: Sample from the LIGO function in the SciVR app.

Subsequent Phase:

Once feedback from the initial phase is compiled and reviewed new 3D learning experiences will be created for chosen 3D relevant topics. Topics include:

- Due to their inherent 3D nature: Mechanisms behind eclipses, tidal forces, and precession of the Earth
- Due to the difficulty in accurately depicting the phenomena: Projection of the celestial sphere onto the night sky, diurnal motion, and the astronomy behind the calendar

Figure 4: (left) Team member Robin Allen using Star Chart™ to explore the solar system. (right) Scan the QR code for more information on this project

References:

Yrjö Engeström, Non scolae sed vitae discimus: Toward overcoming the encapsulation of school learning, Learning and Instruction, Volume 1, Issue 3, 1991, Pages 243-259, ISSN 0959-4752, https://doi.org/10.1016/0959-4752(91)90006-T.

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Funding Provided By: Center for Teaching and Learning, University of Georgia