Outcomes of immersive learning: Comprehension and retention of science content

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In 2009, a NASA grant was awarded to the Louisiana Art and Science Museum, the Houston Museum of Natural Science, and Rice University for the purpose of developing two planetarium shows and interactive games for a portable Discovery Dome.

We Choose Space (2012) and The Great Planet Adventures (2014) were produced and created by HMNS, Home Run Pictures, Tietronis, and LASM to enable the general public to envision the future following the space shuttle program. The two shows address the possibility and feasibility of returning to the moon, as well as possible future missions to solar system destinations and what astronauts’ work/play on these other worlds might look like.

A provision of the grant was to assess and evaluate comprehension and retention of the primary scientific content in We Choose Space. This paper is the summary of the external evaluation of student assessment conducted by NASA scientists and engineers. Questionnaires were developed both by the production team and by teachers at Rice University using science standards.

Multiple-choice questionnaire instruments were administrated to students in both formal (public school) and informal (museum/planetarium) settings. The formal presentations were made via computer; the informal, in the dome.

A total of 370 students ages 11-17 from both formal and informal settings participated by taking pre and post tests and viewing the show We Choose Space. The informal group consisted of 104 students, while the formal group consisted of 200 students.

The evaluation instrument had 16 multiple-choice questions. Each student completed the test prior to viewing the show, and again afterwards, both on the same day.

The middle school students who participated were primarily underserved minorities (African American, American Indian, Asian, Hispanic, and White).

Overall results from the informal and formal educational settings indicated that there was a statistically significant increase in test scores for students who viewed We Choose Space in both delivery systems. However, the mean gain of these test scores was higher for the students who watched the show in the planetarium.

To evaluate long-term retention of concepts presented in the show, the identical post test questionnaire was given to both groups of the same students six weeks after viewing the show. The mean gain results of the post test was higher for the students who watched the show in the planetarium rather than on the computer. In general, test score improvement six weeks after learning in the dome was essentially the same as the post-test immediately after viewing the show, demonstrating virtually no loss of gained information in the six week interval. Students who viewed the show on a computer scored lower six weeks after viewing the show. Numbers in the chart are based on a score of 100. Statistical significance with t- and p-values are not discussed in this presentation, but are given in the handout, or upon request.

Test results show that the mean increase in test scores for learning in the informal environment was 10.47, indicating a significant retention of show material.

In conclusion

There was a statistically significant increase in post-test scores for students who viewed the show in both formal (school lab) and informal (dome environment) settings. (9.2%) Long-term retention of science concepts by
students who viewed the show in the immersive environment had a statistically significant increase in test scores over those who viewed the show on a computer. (7.34%)

Test results were virtually the same after six weeks as they were just after viewing the show in the dome; students who watched the show on a computer retained less after the six week interval.

The planetarium experience is more memorable and better remembered than a comparable classroom experience.

To assess their attitude about the experience of watching the show, students were asked to respond to the following questions.

The bar chart summarizes what students liked best about the show based on a 4-point scale where 1 was Little and 4 was Great.

NASA identified space science education as a method for engaging students in the pursuit of STEM careers with astronauts as role models for students of all ages. They recognized that career choices would be built on experiences that could only happen if students became aware of the programs available and engaged in explorations, either real or virtual. Both these shows were designed to motivate youth to wanting to become astronauts and/or solving challenges for the next generation of scientists and engineers.

About half the students who viewed the show were asked what career they were most interested in pursuing. Out of 198 responses, 102 selected STEM-related careers; 68 selected non-STEM careers (musicians, professional athletes, law enforcement, and lawyers), and 28 students had no preference.

The second show produced, *The Great Planet Adventures*, was completed in late 2014. Unlike *We Choose Space*, the show did not have an external evaluation to compare student learning. Instead, Dr. Sumners delivered an evaluation instrument to students viewing the show in 2015.

The GPA learning objective is to immerse students in 10 environments, with habitats, weather, surface features, and activities consistent with what astronauts would experience on each world. Students also watched astronauts engage in a favorite sport at each destination. Of the 12 destinations in the show that students were asked to respond to, three of the destinations, represented in screen shots below, depict off-world environments: Venus, Uranus, and Mercury.

All pre- and post-questions asked regarding the GPA focused on what students learned in the planetarium environment. The results are highly significant for the whole test with correct answers correlated with the time spent in each environment (indicated on each image).


More information

Both programs are available for sale through Space Update, Inc., a partner of MTPE, Inc., which does business as ePlanetarium®. For the sake of transparency, please note that paper co-author Dr. Patricia Reiff, Rice University (Houston, Texas) formed and leads both MTPE, Inc. and Space Update as a way to market shows, software, and planetarium technology created by the NASA-funded Immersive Earth project and its partners.

Dr. Reiff is professor of Physics and Astronomy and associate director of Outreach Programs at Rice Space Institute.

*We Choose Space:* Covers microgravity and low lunar gravity technology, living and working in space and on the moon habitats. Available in English, Hindi, Spanish, and Telugu; 24 minutes.

*The Great Planet Adventure:* Go along on the adventure on the visit to all the planets and more. Includes 2 free immersive fulldome games: Monster Trucks On The Moon and Mars Flyer. Running time: 24 minutes, with a shorter kids version available. English.

Both program have educator guides and are available in portable, 2k, 3k, 4k, and dvd (for personal and classroom use); general audience, grades 2-12. spaceupdate.com/store/shows_hmns.html