

The Value of Education in the Planetarium

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Prepared for The International Planetarium Society, a nonprofit organization comprised of planetarium professionals from around the globe, by Dr. Jeanne Bishop, Chair of the IPS Education Committee.

What is a Planetarium? A planetarium is a specially-designed theater with a domed ceiling that is able to project a realistic image of the night sky indoors. First used to educate about stars, planets, and constellations, planetariums today are unique immersive facilities often used to support Science, Technology, Engineering, and Mathematics (STEM) learning and to cross learning disciplines into art, culture, and history.

A Brief History: The first optical-mechanical planetarium was introduced in Germany in 1923. Now thousands of planetariums of many types and sizes exist worldwide in schools, museums, science centers, and other locations. Portable planetariums are also used and expand educational possibilities to far-flung audiences. It is estimated that over 1 billion people have been served by planetariums since their introduction.¹ The Soviet cosmonaut who first flew in space and the Apollo astronauts who walked on the Moon 50 years ago were trained in planetariums.

Value of Astronomy: Astronomy is an integral part of human history. Cultural constellation stories reflect how past societies viewed their world. Hunters, farmers, sailors, and other explorers all studied the sky to learn the rhythms of nature for survival and commerce. Understanding modern astronomy helps people comprehend their place in space and time. Astronomical understandings regulate many parts of our lives today: daylight savings time, seasons, the calendar, and also some holidays are determined by sky events. Additionally, the scientific method is demonstrated in a concrete way when we learn about sky objects such as galaxies and black holes.

Unique, Inspirational Environment: Every planetarium immerses visitors in a 3-D environment that evokes realism. The sight of stars appearing in a dark sky, now being lost to light pollution in many areas, immediately captures attention and evokes awe. As cities expand, the lack of personal contact with nature is producing negative psychological effects.^{2,3} A planetarium's night sky is a powerful, memorable, and soothing image which encourages learning. Immersion sparks a viewer's creativity, interest, and engagement, aspects of education's affective domain.

Educational Standards: Earth and Space Science and the scientific method are major themes in national and state pre-college educational standards. For example, countries require teaching the fact that patterns of the motion of the Sun, Moon, and stars in the sky can be observed, described, and predicted, and that seasonal patterns of sunrise and sunset be observed, described, and predicted. Both topics are best taught in a planetarium because of their ability to speed up time and show unobservable phenomena.

A Superior Learning Environment: The immersive planetarium shows learners our universe in ways that flat screen films do not.^{4,5} For example, Moon phases is a projective spatial concept, one that requires a person to mentally switch back and forth between Earth and space views and relate the two perspectives for better understanding. Earlier research had found that most students were unable to reach this coordinated level of understanding of Moon phases. However, it was found to be possible in the fulldome planetarium.⁶

Place for Inquiry-based Learning: Inquiry-based learning is a teaching strategy and learning method that prioritizes student questions, ideas, and analyses. The planetarium environment triggers learner curiosity in ways that normal classrooms cannot. Students are able to discover sky changes that are parts of important long-term cycles, including day and night as a result of Earth's rotation, differences in the daytime paths of the Sun during different seasons, lunar phase and position changes during a month, and planet movement among the fixed stars. Acceleration of these sky changes, so that they occur in a convenient student-visit time period, provides exceptional opportunities for learning astronomy with inquiry procedures.

Reinforcement of Classroom Learning and Retention: Students who attend a planetarium presentation in conjunction with classroom learning,⁷ have the opportunity to resolve misconceptions introduced by 2-D textbook illustrations and computer diagrams. Research is showing that classroom learning coordinated with planetarium lessons show the most gains in knowledge and retention.^{8,9,10,11,12,13} In addition, since many elementary classroom teachers receive limited training in science, the planetarium integration provides them an opportunity to improve their own knowledge and teaching methods.

Help for the Difficult Learner: The planetarium experience can be an important gateway to learning for children who dislike learning in formal environments.¹⁴ Additionally, live planetarium programs benefit learners with short attention spans.¹⁵

Unique Capabilities of Current Planetariums: Increasingly, planetariums employ digital projectors that can zoom the learner from Earth to the Moon, other planets, stars, and distant galaxies. The ability to see objects from different perspectives offers the opportunity to understand our true place in space. Basic spatial understanding, like the Earth's rotation, seasons, and Moon phases can be visualized both from Earth and space.¹⁶ Cutting-edge science research, whose data is normally shown only in spreadsheets, can now be visualized and understood by the general public. Observatories can stream images directly to planetarium audiences, showing real-time views of the cosmos. Additionally, planetariums stream astronomy lectures and multi-discipline programs live to other planetariums in small schools, museums, and even in remote locations.

Multi-Discipline Presentations: Planetariums are natural multi-discipline facilities. Thousands of planetarium programs are offered across the globe and range from live artistic performances to programs that take the audience underwater to learn about topics beyond astronomy. Even foreign language lessons, creative writing sessions, and reenactments of historical events take place in planetariums. Current and future artists, musicians, writers, animators, and many other non-STEM professionals are inspired by planetariums.

Unlimited Possibilities with Digital Fulldome: The evolution of technology extends the possibilities of the multi-discipline planetarium learning environment. Structures and processes within atoms, cells, DNA, human anatomy, land forms, weather systems, and ocean currents can be illustrated at different scales and from different points of view. Simulated trips can take learners to a nuclear power plant, the Egyptian pyramids, the terra cotta warriors of Xian, Greek and Roman temples, the Grand Canyon, Stonehenge, and more. Recent archaeological discoveries at Mayan, Viking, Celtic, and other sites are visualized and shared. Visitors also can travel across geological time periods, historical timelines, and even the predicted futures of human civilization.

A Positive Social Environment: The planetarium is a place where diversity and equality can be promoted, particularly when facilitators use interactive techniques. Live programming provides the opportunity for participants to connect with each other and the presenter. Also, accommodations have been developed for people with disabilities: the visually and hearing impaired, those with autism spectrum disorder, people with intellectual disabilities, and more.

Impacting Communities: Planetariums are not just for young learners. They welcome everyone from the community to attend public events. Many community groups and professional organizations visit the planetarium for lifelong learning experiences. Many STEM-related issues affect our planet today. It is the public who must have the capacity to understand these issues to make informed decisions and encourage powerful, global impact. Planetariums inform the public on these matters.¹⁷

Inspiration to Follow STEM and non-STEM Career Paths: Astronomers, space scientists, and others working in STEM fields were influenced to follow their careers after planetarium visits.¹⁸ Currently, it is estimated that employment in the STEM field will increase by 1 million jobs by 2022¹⁹. Also, the development of planetarium programming requires skills of computer programmers, writers, artists, animators, musicians, and others. These programs in turn inspire future writers, artists, and countless others.

Statements in Support of the Educational Value of the Planetarium

"Student comprehension of complex concepts is enhanced by the ability of the planetarium to compressing-term patterns and cycles into shorter segments which in result in powerful learning experiences."—*The Middle Atlantic Planetarium Society* (www.mapsplanetarium.org)

"The planetarium can motivate students with its stimulating learning situation. Surveys have shown that students like astronomy more than other sciences, and the stimulating environment can build on initial interest and help it develop into a lifelong interest."—*The Great Lakes Planetarium Society* (www.glpa.org)

"Space science makes an important contribution to social, cultural, and intellectual development, which are inseparable from economic development in the long run...planetariums can make an important contribution to the Universe around us."—*Office for Outer Space Affairs, United Nations*²⁰

"The President of the United States, Barack Obama, and his wife and two young daughters attended a planetarium show in a portable dome set up on the South Lawn of the White House on October 7, 2009 at a NASA star party...The President asked a question that had come up during their dinner earlier that evening about the cause of the seasons. I gave a short demo on DigitalSky showing the changing Sun illumination at the North Pole over a six-month period...Later I learned that the family normally spends much less time at White House lawn events than the hour they did that evening--we made an impact."—*Martin Ratcliffe*²¹

"The (immersive planetarium) medium is well suited for productions that combine art and science...While the specific missions of museums vary, it has been argued that imparting a sense of social responsibility is a universal imperative. The capability to deliver powerful media experiences ought to translate into the capability to more deeply influence the visitor's core beliefs and worldviews. This focus on transformation is an emerging trend in fulldome programming."—*Ed Lanz*²²

"The immersive dome experience itself can be an outstanding source of inspiration that will encourage guests to engage in a lifetime process of learning."—*Michael Daut*²³

"Information from research institutions often is a vital part of many planetarium presentations. In this sense, planetariums can function as a media outlet for education and public outreach offices at research facilities. These theatres are an effective magnet for the 'motivated, interested public' that education and public outreach offices seek to reach."—*Carolyn Collins Petersen*²⁴

"Planetariums have a way of attracting people's attention and their imagination, ushering learners into a deeper understanding of scientific concepts."—*Dayna Thompson*²⁵

"The environment of a planetarium provides a family and community gathering place where children and parents can have shared experiences in the learning process."—*Astronomy Literacy, Great Lakes Planetarium Association*²⁶

"We currently are living in a time when truth, reality, and science are under constant fire from sources seeking to spread alt-truths, unsupported fantasies, and disinformation about scientific results...A planetarium can be a place in a school, museum, or science centre that can best present current science information to both students and the general public of all ages in a way that is accurate, engaging, and inspirational. Regardless of whether the facility is analogue or digital, the planetarium can go a long way in helping teach STE(A)M topics and instill the spirit of the scientific method, something people likely will not get in other places."—*Tom Callen*²⁷

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Endnotes

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