Museums and the Grid: Exploration, Implementation, Evaluation

Daniela K. Rosner[1]

[1] Adler Planetarium & Astronomy Museum, 1300 S. Lake Shore Drive, Chicago, Illinois 60605, USA
drosner@adlerplanetarium.org

This paper describes an approach to familiarizing individuals with modern scientific processes through the facilitation of informal learning experiences in and around the museum. Several methods for development of such exhibits and exhibit content are presented. These experiences are discussed and later implemented in the context of the Adler Planetarium and Astronomy Museum in Chicago, IL. The exploration functions as an educational guideline by which museum exhibits may be developed in order to familiarize a more general audience with processes behind scientific research and to make science more personally relevant and inspiring to this museum audience.

Keywords multimedia development; science tools; museum science learning;

1. Introduction

A growing amount of data and data processing in modern science has solicited the development of new tools to combat these challenges. These scientific tools have instantiated collaborative strategies in the scientific community, which have in turn inspired new models for informal learning. The evolution of scientific processes has created a potential for the tools of modern science to effectively aid the general public's understanding of scientific research.

This paper serves to explore and highlight possible applications of Grid computing and similar scientific technologies within science museum education. In the course of this study, methods for evaluation will be presented that investigate whether or not museum learning stands to benefit from existing Grid computing tools and computer-supported collaborative learning (CSCL). A small implementation of an exhibit concept that utilizes Grid techniques will also be presented as part of this analysis.

2. What is Missing in Informal Science Education?

Science museums and school curriculums typically focus their educational goals on teaching the concepts and principals that lead to scientific discovery. Yet the process by which these discoveries are made is often omitted. With the use of Grid computing, collaborative and data-intensive computation are also performed by applications among these processes. The question may be posed, why not expose the methodology behind the science? There is currently little attention paid to scientific process in the informal education environment. Is it due to a perceived lack of interest on the part of the learner? And, if applied to the museum environment, how can cooperative and informal learning benefit from these Grid computing tools?

In order to answer these questions within the context of the science museum, three steps must be taken. First, we must validate the need for developing this kind of exhibit by assessing the needs of the museum audience. Based on this assessment, we can then determine our educational goals, clarifying both the purpose and the method of delivery of our project design. Finally, we must execute this approach in the development of a concrete exhibit design.

The lack of attention paid to scientific tools is not the only content deficiency that may be aided by the introduction of advanced scientific tools such as Grid Computing. There are both physical and conceptual limits to the educational value achieved from a typical museum experience. Traditionally, once a visitor enters a museum, the learning experience is expected to begin, and once the visitor departs, so ends that experience. These borders need not exist in the context of a greater immersive learning environment in which the museum may play only a part. An additional objective is to promote new ways of studying and learning the methods behind science. Previous computer-supported collaborative learning (CSCL) projects include the QuarkNet project [1], which supports the collaborative learning of high-school students investigating cosmic rays; and the CRAC project [3], a higher-education collaborative learning environments. The CRAC project initiates the relationship between Grid and Peer-to-Peer Middleware and Co-operative Learning Environments. (Demonstrated asynchronous distance teaching and learning through the Virtual Campus of the Open University of Catalonia.)

A three-fold exhibition framework will be presented that addresses two goals: 1) increasing the overall public understanding and appreciation for scientific method, and 2) utilizing collaborative learning strategies to mediate the construction, management and dissemination of this knowledge. This preliminary exhibit concept serves as a test bed from which potential educational roles for grid computing and other modern scientific tools may be explored and evaluated.

3. The Grid and Collaborative Learning

3.1 Grid Computing

With vast amounts of data and the need for conducting larger and larger computations, scientists require tools that share and manage that data, and can handle the increasing computational load. In recent years, grid-enabled scientific applications using open source middleware, such as Globus and Condor-G, have allowed scientists to leverage accessible distributed computation. Collaboration in this sense is used to overcome the obstacles of modern science. Conveniently, collaboration is also emerging as an important element of a new educational paradigm that involves interaction between individuals in a virtual environment. This interaction, like that of scientific researchers, is occurring on a global scale, and is often rendered by online collaborative learning or what is termed ‘net learning’ ([9] Harasim, 2000).

3.2 Collaborative Learning

Collaborative learning fosters active and productive participation in a group environment, offering the possibility for better learning and improved development of the learner’s critical thinking skills. The previously described exhibit components have the potential to facilitate such a collaborative learning environment by mimicking the use of the Grid by research scientists. This possibility is perhaps the most novel aspect of this study. However, several instruments must be present in order for museum visitors to employ cooperative computational tools, such as well -designed questions equivalent to grid jobs, which aid the creation of exciting exhibit content.

3.3 Museum Learning using new ScienceTools

The museum learning environment provides a unique opportunity for members of the general public to acquire hands-on science experience that not only explains the methodology behind real science but also allows a museum visitor to mimic those methods. By utilizing pre-existing web-based technologies, a museum exhibit can simulate the research experience of today’s scientists. These museum experiences can reproduce that of scientific research by employing tools for sharing and managing large amounts of data. Museum visitors may thus establish real as well as virtual collaborative learning experiences that transcend the current paradigm for museum learning .

3.4 Formatting of literature citations

References should be numbered (in square brackets, such as [1, 2] or [1–3]) and listed in the order of citations in the text at the end of the manuscript. In Word, do not insert references as endnotes. The preferred citation scheme for the Proceedings is: Initials. Surnames, Journal Title, **Vol. No.** (in **bold** face), starting page (year of publication in brackets) [1]. For books, the following order is required (skip irrelevant information): Authors of Article or Chapter, in: Book Authors or Editor[s] (ed[s].) if no authors, Book Title, edited by Editors, Book Series Vol. No. (Publisher, Place, Year), chap. no., p./pp. page number[s] [2, 3]. When citing conference proceedings, please add all available data such as title, date, and place of the conference as well as publisher, place, and year of publication or, alternatively, the corresponding journal citation.

4. The Exhibit Gallery

4.1 Exhibit Components

To address the fundamental question, “How Is Modern Science Done?,” the practices of *Observation, Data Exploration,* and *Simulation,* which compose the breath of processes behind most modern science, will form the framework for the exhibit story.

The success of presenting new forms of content to an audience is clearly dependent on the production of the exhibit components themselves. Thus, this section introduces designs for several initial exhibit pieces, and a Data Exploration (DE) exhibit that was developed and tested at the Adler Planetarium & Astronomy Museum. Once these exhibit ideas are implemented, an evaluation will subsequently take place followed by an analysis of those assessments.

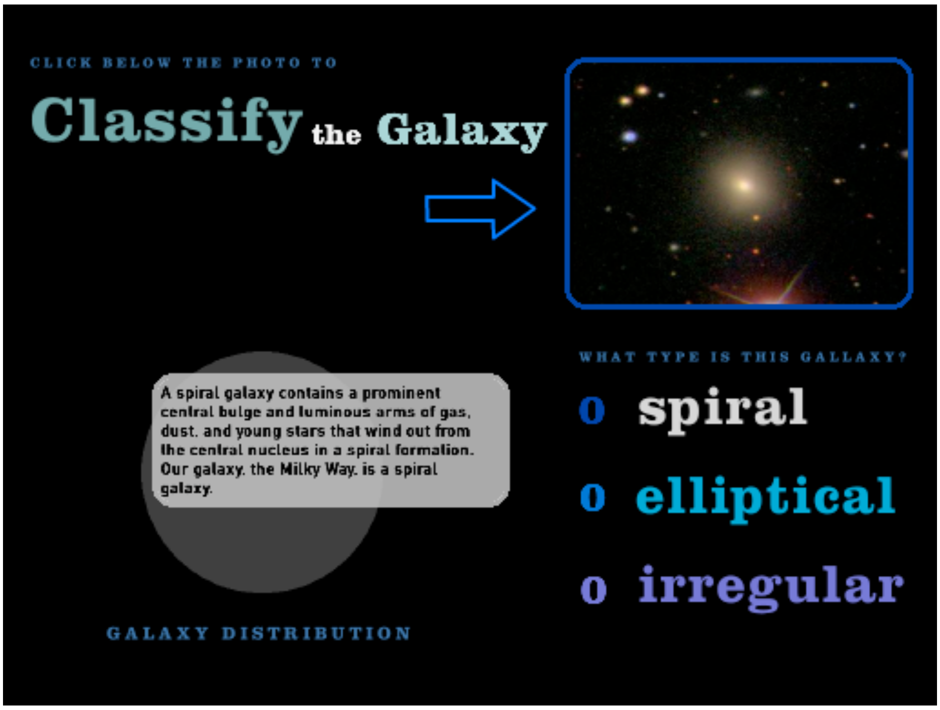
Observation: A graphical display of a world map, possibly a large tiled display wall, may be used to exhibit the telescopes connected to the National Virtual Observatory (NVO). The display would allow visitors to access data from each telescope and illustrate the extent of data that exists.

Data Exploration: The inquiries displayed on the visualization wall can include those from scientists outside the museum and scientists working within the museum, as well as museum visitors with a developed interest in astronomy who conduct research in the area. The exhibit may present a well-defined problem and ask the visitor to analyze the solution. This analysis may involve collaboration between multiple visitors, groups of visitors (such as school groups), or multiple museums. It may also involve the participation of visitors outside the museum. If a query or computation takes time to execute, the visitor may receive a unique user identification that enables him or her to access the results from a webpage at home, or optionally to have the results returned via email.

Simulation: The complexity of modern science presents the largest hurdle in conveying it to a large audience. However, visualization of that complexity can be used as an introduction to and explanation of advanced scientific concepts. Modern simulations are both visually appealing and demonstrative of the advanced abilities of today’s science processes. Utilizing sophisticated scientific tools such as Grid Computing allows these simulations to be created surreptitiously.

4.2 Implementation

The developed Data Exploration (DE) exhibit model asks visitors to solve a simple astronomical question by using a scaled version of tools provided by the National Virtual Observatory (NVO). The original question chosen for implementation was "What is the distribution of galaxies in our Universe?" The exhibit was made available to a randomly selected museum audience for only a few hours over the course of one weekend. Visitors entering the space were asked to interact with a screen-based electronic exhibit which invited them to classify galaxies. The images of galaxies that were provided resulted from queries to the NVO web application OpenSkyQuery, a service that was opaque to the participant. OpenSkyQuery allows for cross-matching of astronomical catalogs and for subsets of catalogs to be selected. It uses a general and powerful query language to accomplish this end [8]. The DE exhibit also made use of the Image Cutout service offered by Sloan Digital Sky Survey (SDSS). This Cutout service was used due to its ability to make individual images of galaxies available based on a given set of parameters. The web service returns a JPEG image centered on *(ra,dec)*, of a given size and scale. Various drawing options can be specified. The image cutout was called through Director, retrieving an HTTP interface using GET. It can also be included in a page through the URL in an IMG tag. Macromedia Director, a current standard for the development multimedia software, provided the means for developing the exhibit's graphic interface and the software to connect to these services.



4.3 Evaluation and Future Development

The exhibit used the National Virtual Observatory (NVO) as a prototype Grid experience. NVO-Teragrid projects include Quasar Science, N-point galaxy correlation, Palomar-Quest Survey, Synoptic survey, the Wide-area Mosaicking (Hyperatlas), and the 2MASS Mosaicking portal. The DE exhibit was thus able to relay the practice of pulling data from a number of telescopes from across the world by asking the visitor to classify those galaxies. The experience resulted in the participant's creation of an estimated galaxy distribution based on his or her classifications. This distribution was visually diplayed on a pie chart that was updated with each classified galaxy. In essence, the participants' challenge was to form their own picture of the distribution of galaxies in the universe.

Based on suggestions made by Adler Planetarium & Astronomy Museum vistors, several improvements and additions will be made to the DE. First, a half-dozen interested visitors, all over the age of 40, inquired whether they could access these services online at home in order to continue exploration.Incorporating this functionality into the exhibit would conintue the visitor's research experience, providing the opportunity for a more thorough learning experience and the emergence of collaborative learning environments. A second extension to the DE is allowing the visitor to undergo a more realistic simulated research process, giving the visitor a choice of hypotheses to investigate, explore, and analyze.

3. Conclusion

In science education today there is little consideration for the public understanding of scientific method. Complementary to this gap in educational content, few informal education environments make use of computer-supported collaborative learning (CSCL) to facilitate educational exploration. Science museums and informal educational programs in particular, have great potential for merging both deficiencies to benefit a broad public audience. By exposing and simulating scientific processes such as the use of tools involving the distribution of resources and, more specifically, grid computation, shared interactive experiences may be harnessed to deepen a visitor's understanding of science and increase the segment of the community that is familiar with the scientific process. Thus, modern techonological tools may provide a mechanism by which individuals can be uniquely immersed in a multifaceted cooperative learning experience.

Acknowledgements The support by the Adler Planetarium & Astronomy Museum

References

[1] M. Bardeen et al. (2004) *The QuarkNet/Grid Collaborative Learning e-Lab* quarknet.uchicago.edu/elab/cosmic

[2] Miguel L. Bote-Lorenzo et al. (2003), *Miguel L. Bote-Lorenzo, Grid Characteristics and Uses: a Grid Definition*

[3] O. Ardaiz, P. et al.. (2003) *ULabGrid, an infrastructure to develop distant laboratories for undergrad students over a Grid*

[4] American Association for the Advancement of Science Staf *Atlas of Science Literacy,* August 2000

[5] Foster I., Kesselman C., Nick J., Tuecke S. (2002). Grid Services for Distributed System Integration. Computer,

[6] Ewing J., Miller D. Miller: A framework for evaluating computer supported collaborative learning

[7] Daradoumis, T., & Marquès, J. M. (2000). A methodological approach to networked collaborative learning: Design and pedagogy Issues.

[8] Boroson, T. et al. (2000)*White Paper Towards a National Virtual Observatory: Science Goals, Technical Challenges, and* Implementation *Plan*

[9] Harasim L. (2000). "Shift Happens: Online Education as a New Paradigm in Learning," Internet and Higher Education: Special Issue. UK: Elsevier Science 3