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Astronomy Education Review

2010, AER, 9, 010112-1, 10.3847/AER2010016

Survey of the Goals and Beliefs of Planetarium Professionals Regarding Program Design

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Received: 06/14/10, Accepted: 08/3/10, Published: 09/1/10

Abstract

Despite decades of research on the importance of engagement and interaction in learning experiences, programs produced for planetarium audiences are primarily passive in nature. Planetarium professionals were interviewed with regard to their goals and beliefs for planetarium experiences, specifically focusing on goals for children, and their interest with regard to a program format that integrates segments of live interaction with automated content (N=36). Planetarium professionals' goals most frequently reflect increasing content knowledge and motivating audiences to continue learning. To meet these goals, they often cite live interaction as a key strategy for elementary-aged audiences. Further, planetarium professionals often combine live interaction with prerendered automation. These results suggest that the planetarium community's goals and beliefs are at odds with the current model of passive planetarium production and that the frontline professionals would support opportunities that support their ability to actively engage their audiences.

1. INTRODUCTION

It has been over 10 years since the first permanent fulldome planetarium system was installed in the United States at Chicago's Adler Planetarium. Currently, there are over 3000 planetarium facilities worldwide with estimates of about 600 with fulldome projection technology by 2010 (Bruno 2008). The planetarium field is in a state of evolution with fulldome technology continuously replacing traditional theaters. In the last 2 years, the number of fulldome theaters worldwide has doubled (Petersen 2009).

While utilizing the latest technologies is progressive and an appropriate direction for the field, the types of programs that are being created for fulldome theaters are largely push-button initiated with no built-in interaction with a live presenter. Therefore, the commercial program options for fulldome planetarium facilities are those that provide audiences with a completely passive experience. Given the difficulty, time, and expense in creating a professional quality fulldome program, many planetariums are not able to produce their own high quality in-house fulldome programs. As facilities continue to adopt these passive presentations, the opportunities for audiences to experience active engagement in the planetarium are increasingly limited.

Many professionals in the field support the restoration of active educational experiences in their facilities. In a study of leaders of the planetarium field, James Croft (2008) found that instead of focusing on entertainment as their primary goal, as might be expected if planetarium professionals favored passive fulldome movies, planetarium professionals strive to educate their audiences and work toward communicating complex scientific ideas using the planetarium medium. These beliefs are echoed in a recent article on planetarium professionals (Littman 2009). "The function of a planetarium is to educate," says Dr. Ronald Kaitchuck, Ball State University. "That's not what movie theaters do. If planetariums try to become movie theaters, they're doomed." Dennis Schatz, Pacific Science Center, agrees; he thinks too many planetariums are trying to duplicate an

IMAX thrill show on their domes. "They're losing connection to the night sky and the basics of astronomy." Kaitchuck continues, "A key part of the planetarium experience for young and old alike is contact with a live person who can answer questions and inspire. That makes it a personal experience."

Educational research (including studies conducted on planetarium learning experiences) indicates that active experiences for audiences are more effective in promoting the types of cognitive engagement that produce affective and cognitive changes [e.g., Bell *et al.* (2009), Brazell and Espinoza (2009), Donovan and Bransford (2005), and Donovan, Bransford, and Pellegrino (1999)]. This is particularly true for children, as interaction will increase their focus and help make experiences less abstract. Different approaches to children's planetarium programs versus adult programming may exist because of the shorter attention spans and level of cognitive processing of younger audience members. However, these research findings seem to be at odds with the trend of current planetarium programming toward continuing to develop passive movielike productions. Therefore, this study explores planetarium professionals' opinions on the design of learning environments for younger audiences and their views on providing educational experiences for children in the dome.

Planetariums can provide unique informal educational experiences to audiences but improving audience member's conceptual understanding of astronomy lies in the program implementation. Instruction must actively engage children in comparing their initial ideas to the scientific ideas in order to facilitate conceptual change (Bransford, Brown, and Cocking 1999; Sinatra and Pintrich 2003). This piece of active engagement is critical to either simple assimilation of a new but compatible idea or a more extensive restructuring of existing ideas. In the 1970s, the planetarium community began to discuss how to actively engage the audience in "participatory oriented programs" rather than the traditional lecture model (Friedman, Schatz, and Sneider 1976):

> A very exciting alternative to a passive-audience program that relies on elaborate special effects is the "participatory oriented planetarium" programs now being used at more than a dozen smaller planetariums. In these audience participation programs, the visitors are actively involved in 1) discovery-approach activities and 2) extensive verbal interactions with other audience members and the planetarium instructor. The most important distinguishing feature of a participatory oriented program is that the audience is actively involved in thinking about the subject matter, not passively absorbing audio-visual information. (p. 4)

In 1982, Mallon and Bruce investigated the use of participatory oriented programs in small educational planetariums. Through a paper-and-pencil content test and a Likert-style science opinionnaire, they found that the participatory oriented program was more effective than a traditional program in teaching constellations and possibly for improving students' attitudes toward astronomy. Bishop (1980) found that model manipulation and drawing in the planetarium can help students learn projective astronomy concepts (such as the day-night cycle and the phases of the Moon). Sarrazine (2005) successfully supported middle school students' understanding of the phases of the Moon using participatory oriented programming with a strong emphasis on multiple intelligences. Plummer (2009) published a study of a participatory planetarium program in which first and second grade students showed significant improvement in understanding apparent celestial motion concepts. This improvement can be attributed to the use of kinesthetically and visually interactive live techniques in the program. However, these studies focused on programs implemented by the researchers; little has been published on a more general population of planetarium professionals and how they view these types of interactive programs.

Our review of the literature on planetariums and the state of the planetarium field suggests that a gap exists between the nature of the current fulldome program design and planetarium professionals' beliefs. In this paper, we explore three questions to analyze aspects of the current state of the planetarium field and how the beliefs and opinions of professionals reflect this current state.

1) What are planetarium professionals' goals for audiences and beliefs about designing planetarium programs?
2) What additional goals and beliefs are held by professionals about planetarium education for elementary-aged children (grades K-4)?
3) Are planetarium professionals currently integrating live content with prerecorded content? If so, how are they doing this?

Overall, the answers to these questions will be used to determine whether current passive programming supports planetarium professionals' beliefs about planetarium education. To answer these questions, professionals attending regional planetarium conferences were interviewed. Attendees of planetarium conferences were chosen for two reasons. First, this allowed us to access a large population of planetarium professionals to draw on a broad spectrum of the community. Second, these are individuals who are engaged in their community. They are likely to stay current with the planetarium field and look for new ways of reaching their audiences. Planetarium conferences are a key place for program producers to introduce their products to the community. Thus, the opinions and beliefs of these attendees will allow us to answer our question about the relationship between planetarium professionals' beliefs and the current state-of-the-field (passive planetarium programming).

2. METHODOLOGY

2.1. Interviews

Interviews were conducted at two annual meetings of regional planetarium associations as well as over the telephone with conference attendees who wished to participate but did not have time to be interviewed onsite. Conference attendees were invited to participate in the study a) through a public announcement during the presentation session at the beginning of the conference and b) as individuals entered the vendors' hall. Conference attendees were told that the researchers were interested in knowing more about planetarium professionals' beliefs about how programming should be designed and delivered. In total, 36 planetarium professionals (25 male and 11 female) were interviewed (31 onsite; five by telephone). This included vendors who may have worked at planetariums in the past as well as current planetarium directors and operators. Subjects were chosen based on willingness to volunteer to be interviewed and signed a consent form.

A semistructured interview was used to allow participants to provide rich and detailed responses. The interview consisted of questions covering demographic information, goals for the planetarium, opinions about general show characteristics, live interaction in the planetarium, and their thoughts on adding live interaction to prerecorded programming (Appendix). Two additional questions were asked only of the participants in the second set of conference interviews based on topics that arose during the first conference interviews. Some participants were not asked questions that did not relate to their practice. For example, vendors and consultants who did not or had not worked as a planetarium operator were not asked questions about experiences related to delivering planetarium content to audiences. Interviews were conducted on a one-on-one basis by the second author. Interviews ranged in length from approximately 6 to 41 min. Interviews were audio-recorded for later analysis.

2.2. Analysis

A series of categories was developed based on the interview questions and our research questions. Codes were then developed using the constant comparison method (Strauss and Corbin 1998). We developed a set of initial codes representing concepts that we expected to see in the interview data. Then, both authors listened to a subset of four interviews to develop additional codes to describe concepts that appeared in the data. The remaining interviews were split, with each author coding 16 interviews. Periodically, during this coding process, the authors met to compare coding and determine whether new codes should be added or old codes should be clarified. Each author then reviewed previously coded interviews to match any changes produced in discussions. Finally, four interviews were randomly selected from each subset of 16 interviews, to be coded by both authors (for a total of eight interviews). An inter-rater agreement of 96% was reached in this final comparison.

3. FINDINGS

3.1. Demographics

The majority of participants (56%) have been in the planetarium field longer than 15 years. Participants were drawn from school districts (19%), universities (28%), museums and science centers (19%), planetarium vendors (11%), and other work situations (17%), with two unknown. A majority of the fixed planetarium theaters in the United States is associated with an educational or cultural institution (Petersen 2009). Thus, the interview participants were representative of the types of facilities housing planetariums. Table 1 reports the distribution of jobs held by the participants.

Table 1. Reported current planetarium-related occupation of participants

Occupation	N = 36
Planetarium	19
Director/coordinator/supervisor/manager	
Planetarium operator/presenter	5
Vendor	4
Planetarium consultant	2
Unemployed/retired	2
Education specialist/outreach for government	1
Other management position	1
Planetarium technician	1
Self-employed	1

The participants in this survey reflect the growing trend toward fulldome technology. Slightly over half of the asked participants (53%; n = 30) reported that they currently work with fulldome technology. (Six participants were not asked if they work with fulldome technology because of their current employment status.) Four other participants reported that they hope to have fulldome technology in their facilities soon, suggesting fulldome technology will continue to increase in the near future.

3.2. Goals for the Planetarium

Analysis suggests that the planetarium community holds multiple goals for their audiences including increasing knowledge of astronomical concepts, increasing interest in and promoting awareness of astronomy, and providing an educational experience. The most frequently mentioned goal by the participants was to educate audiences about specific content (see Table 2). For example, Tom, a school district planetarium director with 18 years in the field, describes one of his goals as:

> The goal of the planetarium is to take them [audience members] one step further than they came in with for their understanding of the universe around them. (Tom, Planetarium Director)

Research supports the usefulness of this goal, as short interventions, such as experiences in the planetarium (Bishop 1980; Plummer 2009; Sarrazine 2005) or museum visits [Falk and Storksdieck (2005, 2009); see Rennie and McClafferty (1996) for a review], have been found to have an impact on audience learning. Addressing alternative conceptions (misconceptions) was also part of this goal (educating audiences about content); however, few participants (8%) included this in their responses.

Table 2. Goals for the planetarium

General Goals	n = 28	Learning Goals for Children	n = 30
Education about content/prior knowledge	20 (71%)	Interest/engage	18 (60%)
Interest/engage	19 (68%)	Education about content/prior knowledge	17 (57%)
Provide an educational experience	8 (29%)	Teach state or national standards	13 (43%)
Not just facts	6 (21%)	Knowledge of the sky	7 (23%)
Entertainment	6 (21%)	Education about scientific reasoning	6 (20%)
Education about scientific reasoning	5 (18%)	Provide an educational experience	5 (17%)
Knowledge of the sky	4 (14%)	Not just facts	4 (13%)
Teach state or national standards	2 (7%)	Entertainment	0 (0%)

Note: Individual participants may have been coded in more than one possible goal.

The planetarium professional's second most frequent response regarding goals of the planetarium was to increase audience interest in astronomy or science. Participants indicated that a planetarium should inspire interest and create emotional responses that make audience members want to come back or go out and learn more. There is some indication that planetariums can increase interest in astronomical topics (Mallon and Bruce 1982;

Mergler 1975), though at this time we lack a detailed understanding of what particular characteristics of the audience and the programming produce specific types of interest [see Falk and Storksdieck (2005) for characteristics influencing learning].

Participants mentioned other goals less frequently (Table 2). Some of these goals relate to how the content of a program should be expressed, such as focusing on a few important concepts rather than a lot of facts, or increase knowledge and appreciation of the nighttime sky. It should be noted that the professionals' whose comments indicated entertainment as one of the goals of the planetarium still considered educational motives. They believe entertainment engages audiences to motivate and maintain attention, resulting in increased learning.

When specifically asked about their goals for educating children (grades K-4), participants most frequently chose the same goals as they did for general audiences: Increased interest and education about astronomical content (Table 2). Joe, a vendor with 30 years experience in the field, expressed both of these views. He cited the importance of teaching astronomical content, such as the Sun is the star and our view of the universe is a result of our motion on a spinning globe, as well as stating the following:

> We need to get them [children] excited about science and astronomy; it is not about passing a test but to inspire them to learn more. (Joe, Vendor)

There was a noticeable increased emphasis on teaching state or national standards when working with children. This can be interpreted as a response of planetarium professionals toward meeting the needs of formal educators. Many children attend planetariums as part of a school field trip, and therefore planetariums often assume the role of assisting formal educators in meeting specific state or national science standards. The goal was expressed by professionals across the venues sampled, not just school district planetariums. This trend also may be reflected in the fact that no participants in this study mentioned entertainment as a key goal for programs that are designed to target children in the K-4 age range.

3.3. Opinions on Planetarium Program Design and the Views on Live Presentation

Given the prevalence of passive planetarium programs in the field, one of the goals of this study was to uncover planetarium professionals' opinions on how planetarium programs should be designed for children, specifically grades K-4. Ninety-three percent (n=30) of the interviewees who currently present in a planetarium indicated that they run programs for this age range in their domes. All participants were asked to describe what they believe to be important in the design of planetarium programs for children to meet their previously stated goals. The two most frequent responses were presenting material at the appropriate level and including live interaction (Table 3). Responses coded as indicating "appropriate level" included "…the show has to be something the kids will be able to identify (Harry, Vendor)" and "look at research on pedagogy of what is appropriate for various age levels…work with school's curriculum for various grades (Sue, Planetarium Director)." Joe's response was coded as indicating the importance of live interaction: "The person presenting the program will interact directly with them and share their excitement about the subject." Others described the importance of involving and reacting to the children, engaging them in hands-on activities or making eye contact.

Table 3. Opinions on planetarium program design for K-4

K-4 PT Show Design	N=36
Appropriate level	27 (75%)
Live interaction	24 (67%)
Visualization	8 (22%)
Realistic	7 (19%)
Prior knowledge	7 (19%)
Storytelling	4 (11%)
Inspirational	4 (11%)
Assessments	2 (6%)

Note: Individual participants may have been coded in more than one possible opinion.

3.4. Live Interaction

When designing this study, we already had planned to ask participants to describe their beliefs about the use of live interaction in the planetarium. Our finding that two-thirds spontaneously mentioned this concept when offered an open-ended question about how to design planetarium programs (described in the previous section) made the follow-up question about the importance of live interaction an unintended synergy in the study design and participants' beliefs. In this section, we describe participants' responses regarding their beliefs about, and use of, live interaction.

All participants were asked to rate the importance of live interaction in a planetarium program on a scale of 1 to 10 (with 10 being very important) to begin the conversation about the relative importance to program design. The most frequent response was a 10 reported by 20 participants (while three others gave 11 or 12). Thirty-two (89%) participants rated the importance of live interaction with an 8 or higher. Two participants did not give a number, although they both verbally supported live interaction in planetarium programs stating live interaction is "vital" and "extremely important." All participants who indicated that they currently present in the planetarium stated that they give live programs at their facilities (n=30).

While these responses indicate live interaction's importance to planetarium professionals, there are a broad range of strategies in how they *defined and described* using live interaction. The major themes uncovered in the interview data include the use of questions, dialog, physical interaction (including kinesthetic activities and the use of props), and general engagement. Table 4 indicates the frequency of various definitions of live interaction.

Table 4. Planetarium professionals' definitions of live interaction

Define Live Interaction	N=36
Operator asking questions	26 (72%)
Kinesthetic activities	25 (69%)
Use of props	22 (61%)
General engagement	16 (44%)
Audience members asking questions	13 (36%)
Questions and answers during the program	11 (31%)
Dialog	10 (28%)
Giving instructions	3 (8%)
Use of clickers	3 (8%)
Questions after the program	1 (3%)

Note: Individual participants may have been coded in more than one possible definition.

3.4.1. Use of Questions

We looked for evidence of both operators and audience members *asking questions* as part of our participants' definitions of live interaction. We predicted that question/answer after the program would be a commonly mentioned aspect of live interaction; however only one professional mentioned this in their interview. Eleven participants (31%) mentioned using questions during the show as part of live interaction. Twenty-six participants (72%) included operators asking audience members questions as part of their definition of live interaction. Thirteen participants (36%) also suggested that the audience asking questions is part of the definition of a live interaction.

3.4.2. Dialog

Ten participants (28%) described *dialog* as an aspect of interaction in the planetarium. One participant included audience members talking to one another. The rest described general conversation, presenter talking to the audience, or active discussion. Common phrases used by participants in describing live interaction included "active discussion," "interchange," and "conversations." Three responses indicated the operator *giving instructions* as part of live interaction.

3.4.3. Physical Interaction

Twenty-two participants (61%) including the *use of props* as part of their definition of live interactions. Thirteen (36%) of these participants clearly indicated the audience members' use of props as part of live interaction. The remaining participants either use props as demonstrations, or the use was unclear. Props included light ropes, light sabers, balls, models, and diffraction gratings among many others. Twenty-five participants (69%) indicated the use of *kinesthetic activities* in their definition of live interaction. (Examples require the audience to move but do not specifically require the use of a physical prop.) Kinesthetic interaction was most commonly mentioned in simulations and role playing, pointing and tracing, and generic references to kinesthetic actions. Three participants mentioned *clickers*, though only one of these was referring to their own practice.

3.4.4. General Engagement

We found a broad range of additional aspects of participants' definition of live interaction that did not otherwise fit the previous categories. These included challenge them, engage through seeing audiences' blank look, use scientific inquiry and exploration, communicate enthusiasm, relate to them/make it personal, use direct eye contact, change presentation approach or level in response to differences in the audience, use humor, and be animated.

3.5. Combining Live with Automated Programming

The previous sections demonstrate that live interaction is valued and used by the planetarium community. This led us to discuss how planetarium professionals' beliefs and practices may combine automated programs with their use of live interaction. Analysis revealed that combining live interaction with automated programming is common among planetarium professionals. Twenty-six (87%; n=30) reported that they combine live interaction with automated programming, and three (10%) reported that they do not. (One was unclear.)

Planetarium professionals mix live presentation with automated programs in a variety of ways (Table 5). Participants most frequently included live presentation after an automated program, such as a star identification talk, and automated segments (e.g., video clips, musical segments, etc.) within a live program. Other reported descriptions of mixing live presentation with automated programming included an automated section at the end of a live presentation, pausing automated programs or clips to add live segments in a presentation, a live presenter talking to an automated character, and talking over video clips. These results suggest that planetarium professionals draw on automated content in a flexible manner toward supporting their understanding of how program design can be used to meet educational goals for audiences.

Table 5. Methods of combining live with automated programming

Mixing Live Content	n=28 [a]
Live segment following an automated program	14 (50%)
Automated segments embedded in a live program	14 (50%)
Live segments before automated segments	8 (29%)
Multiple stops and starts of automated program to add live segments	8 (29%)
Live segments embedded in automated program	4 (14%)

Note: Individual participants may have been coded in more than one possible method.
[a]One of these participants only gives live programs.

4. CONCLUSION

The identification of planetarium professionals' goals and beliefs toward the planetarium as an education venue is an important first step toward developing opportunities to support professionals and toward designing programs that will be adopted by the community. Our findings suggest that most planetarium professionals see their role as providing audiences with an opportunity to learn more science content and to be inspired to continue learning more in the future. Participants indicated these goals for both general audiences and elementary-aged children. Similar to Croft's (2008) smaller study of leaders of the planetarium field, we conclude that planetarium professionals are far more interested in educating their audiences than entertaining them.

To support these goals, planetarium professionals believe in the use of live interaction rather than passive program design strategies. Further, when considering the design of programs for younger audiences, nearly all planetarium professionals believe live interaction is central to their work, but there are a variety of forms that this interaction takes. That many professionals use kinesthetic and haptic learning strategies as well as dialog in their programs is promising for the educational value of planetarium programming. And planetarium professionals' interest in combining the positive qualities of an automated planetarium program with live interaction opportunities suggests that the field will support non-traditional forms of programming.

Thus, we return to our original question of whether passive planetarium programs are aligned with the goals and beliefs of planetarium professionals, especially for younger audiences. These results suggest that the current selection of passive programming is not necessarily the optimal experience that professionals in the field want to provide their audiences. These results have implications for the direction of the field; planetarium professionals want educationally oriented programs that offer the opportunity to interact with their audiences. Companies that produce planetarium programming may wish to consider these interests by designing programs that offer presenters the opportunity to be flexible in their use of the fulldome planetarium capabilities. The large representation by educational venues (such as school-based planetariums) further suggests a need for flexible, participatory oriented, planetarium programs that are aimed at younger audiences. A second implication of this study is addressed to those interested in providing professional development opportunities for planetarium professionals. Given that planetarium professionals believe in both the importance of educating audiences on scientific content and interacting live with their audiences, successful professional development should be designed around supporting professionals' use of new interaction strategies. And because nearly all of the professionals who currently give shows include elementary-aged audiences, professional development opportunities designed around interactive strategies in standards-based elementary astronomy content are likely to be well received.

The study described in this article was an initial attempt to uncover the beliefs and practices of planetarium professionals and to understand the relationship between frontline professionals and vendor-produced programming. Certain limitations may arise from the design of our study. As participants were not randomly selected but instead volunteered to be interviewed, we may be biased toward practitioners who agreed to be interviewed because they are more engaged in thinking about ways to interact with their audiences. We attempted to reduce this bias through our description of the study and invitation to participate; when announcing our study, we encouraged people of all perspectives to talk to us to get the full range of opinions in order to acquire a balanced sample. Another potential limitation in this study is that we only interviewed people who attend planetarium conferences. It is possible that the planetarium professionals who choose to or are able to attend planetarium conferences represent a select group in terms of their beliefs and goals for the planetarium. However, participants in this study are representative of the broad spectrum of venues and jobs associated with the planetarium field. A further limitation of this study was that it scarcely (if at all) included the opinions of the decision makers that are responsible for actually producing commercial quality fulldome productions. Are there specific reasons why fulldome planetarium program producers are predominantly making passive programs rather than programs designed to facilitate active engagement? Are there multiple cohorts in the planetarium community that assign different value to the types of experiences that audiences can have in a planetarium (educators versus "movie-makers")? Future research exploring these questions will help the field move forward in increasing the educational value of the planetarium.

Appendix: Interview Protocol

1. DEMOGRAPHICS

1. Did you listen to our presentation?
2. What is your current job? [If the answer is not clear, How does this relate to the planetarium field?]
3. How long have you been in the planetarium field?
4. What is you background in astronomy, science, or education?
5. Do you have any formal education training?

6. What kind of professional development have you participated in related to planetarium work or teaching?
7. Do you have fulldome technology in your planetarium? [If interviewee does not work in a planetarium, Do you have any interaction with full dome technology?] Do you foresee having it in the near future?
8. Do you choose or are you part of a team that chooses which shows to purchase for your facility?
9. Do you run live shows?
10. Have you ever mixed live content with a pre-recorded show? Describe.
11. Do you run shows that cater to K-4 grades? If not, what other groups?
12. Does anyone else besides you run shows? What is the general training and background of the people who run your shows?

2. OPINION ABOUT GENERAL SHOW CHARACTERISTICS

1. What are your goals for audiences in the planetarium? Or, what do you consider to be the central role of the planetarium?
2. What should K-4 grade students be learning from attending a planetarium program?
3. Do you have any goals for K-4 grade students in terms of their interests after attending a planetarium program?
4. What do you think is important in the design of a planetarium show for K-4 grade students? (Content? Execution? Length? Standards?)
5. On a scale of 1–10, with 10 being most important, how important is live interaction for educating K-4 students? [Make sure they explain.]
6. How do you define live interaction and what aspects are most important? (Give examples.)
7. Do you use question/answer during (not just after) a show?
8. Do you involve the students in ways beyond question and answer (such as using their bodies or through the use of props)?
9. What has influenced how you use live interaction in planetarium programs?
10. Where do you get new ideas for or learn new ways of interacting with audiences?

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