

## **Impacts of Chandra X-ray Observatory Education and Public Outreach**

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**Abstract.** The overarching goal of Chandra's multifaceted communications and public engagement (EPO) program is to open access for anyone to be a learner and explorer of the Universe. To achieve this goal, the Chandra EPO team develops products and activities that share new discoveries about the Universe with diverse audiences, engages the imaginations of students, teachers, and the general public, and increases learning opportunities. We partner with organizations such as the National Science Olympiad, the 4-H, the NASA Museum Alliance, and the American Library Association to leverage their distribution networks for national impact. We summarize the results of a sample of wide-reaching, synthesized suite of programs—ranging from press, to outreach, to informal and formal education—that communicate the compelling topics that only the high-energy Universe can reveal.

### **1. Description**

The EPO team at the Chandra X-ray Center (CXC) is responsible for all aspects of production and dissemination of information about the Chandra mission and its science results. Key components of the success of the program are the direct connection and close working relationships established with the astrophysicists whose research forms the basis for all products. The components are categorized into three functional areas: communications, public engagement, and education.

The communications activity produces dozens of press releases and feature articles every year, including higher-profile press conferences when appropriate. Press material from the Chandra website flows to NASA's web portals as well as to news and science education websites where it becomes part of our public engagement efforts. Selected topics are folded into Chandra's formal and informal education programs, which are aligned with national teaching and professional development standards for Science, Technology, Engineering, and Mathematics (STEM) subjects and with the Science Mission Directorate's (SMD) Education Strategic Framework.

The Chandra EPO group's internal and external partnerships are a key component for leveraging expertise, audience building, knowledge sharing, and creation and dissemination of high-quality Chandra resources.<sup>1</sup> Such partnerships allow and encourage network building, synergistic activities, and innovative approaches to communicating with public audiences.

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<sup>1</sup>Listed at <http://chandra.si.edu/impact/partnerships.html> are some of the most recent partners and programs that have worked with the Chandra program.

## 2. Overview of Selected Products and Activities

In addition to hosting press materials, the Chandra public website is a comprehensive, disabilities-accessible portal, featuring such Web 2.0 elements as high definition (HD) video podcasts, blogs, user ratings and comments, interactive features, and links to social media. The Chandra communications team prioritizes awareness of trending platforms and tools, and adapts accordingly to best respond and engage with the public. Education professional development sessions have been recorded and posted online to allow review of the content.

The Chandra team has initiated “Aesthetics and Astronomy,”<sup>2</sup> a research project that has revealed a series of “best practices” which have been applied to Chandra visualizations and text used in press releases, web presentations, multi-media products, and public exhibits. The findings are reported in science communication journals and conference proceedings for the American Psychological Association. A blog-based website was created to disseminate findings to outreach practitioners.

The Chandra team supports several public engagement projects and has considerable reach. The National Science Olympiad competitions for middle and high school students involve 6,800 teams and their coaches, including over 100,000 students per year. We infused NASA science results into the competition tests, provided training and study outlines for the coaches, and linked the team members and their coaches with NASA resources.

Since 2009, the Chandra EPO group has conceived of, designed, and implemented large-scale projects referred to as “public science:” *From Earth to the Universe* (FETTU), *From Earth to the Solar System* (FETTSS), and *Here, There and Everywhere* (HTE). These projects have allowed Chandra and other NASA content to be placed in non-traditional venues such as public parks, shopping malls, and metro stations where they have been seen by tens of millions of people. These projects address the lack of understanding and awareness of STEM topics in the U.S., and evaluations of these efforts have shown demonstrable increases in interest and learning gains of these subjects. Results have also shown the creation of new informal science education networks, content dissemination, and additional capacity building, which empowers local organizations to become trusted science outreach organizers for their community. These public science projects have reached diverse audiences such as Spanish speakers in the U.S. and the visually impaired (through tactile-Braille and audio versions), thus broadening opportunities for engagement with NASA content.

Chandra’s education activities include professional development workshops for classroom educators, providers of informal education programs in museums, and teachers in after-school programs and community organizations. We provide educators with standards-based resources and knowledge to infuse NASA SMD content into their activities and classrooms, and to develop materials and activities that increase student interest in NASA SMD science and STEM subjects. Chandra professional development workshops at the National Science Teachers Association (NSTA) meetings are evaluated not only by our outside evaluators but also using NSTA’s own survey instruments. All educational material presented has been approved through the NASA product review.

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<sup>2</sup><http://astroart.cfa.harvard.edu>

The Astrophysics Summer Institute (ASI) is a unique program for high school students offered in conjunction with Rutgers University. ASI developed an easy-to-use suite of analysis tools that enables students to carry out analysis of real data sets from Chandra Observations. The ASI program provides mentors for students while they carry out individual year-long research projects.

### 3. Evaluation

Summary surveys of specific products, longitudinal studies of usage and impact, focused studies to determine needs and content, and formative and summative evaluations of specific products or activities have been completed by the Goodman Research Group (GRG), an independent outside evaluator. Previous years' evaluations have focused on the effectiveness of teacher professional development workshops, on the impact on student education and career choices of Rutgers' ASI participants,<sup>3</sup> on usage and effectiveness of the public website, printed materials, and materials and activities intended for classroom use, on preferences for formats and platforms for particular kinds of materials, on preferred science topics, etc. Here we provide a summary of selected results.

Evaluation results from GRG about the usefulness of the Chandra website as a public resource show that 92% of survey respondents agree that the Chandra site is "a valuable resource," "a good source of new ideas," and that it "contains comprehensive information about astronomy."

In a longitudinal six-year survey of the Rutgers ASI program, the participants were asked a series of questions about the impact of the program on their continued participation in STEM fields and on their attitudes toward learning in general; 65% said that the program made them "somewhat" or "much more" inclined to pursue more education in STEM; 83% of those enrolled in or completing a degree program reported majoring or minoring in a STEM subject; 68% rated the program as one of their top three educational experiences. An additional 7% rated it as their top educational experience. Qualitative assessment of the learning experience during the ASI was showed very good learning results, rated on a scale of 1 to 5 (where 5 = "learned a great deal"). The mean responses in the following areas were: astronomy learning, 4.52; methods of data analysis, 4.34; skills in interpreting scientific data, 4.28; telescopes and satellites, 4.12; and experimental techniques in science, 4.04.

The Chandra program produces materials for use in the classroom and out-of-school settings. We continue to offer selected content in printed format to meet the needs of schools, programs, and students with varying access to technology. Demonstrations of the hands-on use of materials were conducted in professional development workshops at the National Science Teacher Association regional and national meetings. When asked how effective the Chandra program and products are in fostering engagement with, and awareness of, space science research, 73% reported that the workshop activities were very or extremely effective in engaging students, and 82% of respondents had or planned to request additional materials. 85% of respondents reported that the classroom activities presented in professional development workshops were very or extremely effective in helping students learn the relevant scientific concepts.

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<sup>3</sup>[http://xray.rutgers.edu/asi/asi\\_general.html](http://xray.rutgers.edu/asi/asi_general.html)

#### 4. Conclusion

Chandra's EPO group is conducting a wide-ranging program to disseminate the results from the high-energy Universe to large and diverse audiences through press, public engagement, and informal and formal education products and activities. The evaluation data collected and analyzed to date demonstrate the effectiveness and impact of these efforts. We continue to share best practices with the EPO community through publications.<sup>4</sup>

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<sup>4</sup>For additional details, reports and evaluation metrics, please see <http://chandra.si.edu/impact/index.html>.