The NASA Galileo Educator Network: Using Astronomy to Engage Teachers in Science Practices

Brian Kruse, Kristin M. Bass, and Greg Schultz

1Astronomical Society of the Pacific, San Francisco, California, USA
2Rockman et al, San Francisco, California, USA

Abstract. With funding from a NASA EPOESS grant, the Astronomical Society of the Pacific developed the NASA Galileo Educator Network (GEN), a train-the-trainer teacher professional development program based in part on the Galileo Teacher Training Program. Formal evaluation of the program demonstrates that both teacher trainers and teacher participants grew in their ability to utilize astronomy investigations focusing on science practices as described in the Next Generation Science Standards.

1. Introduction

The Galileo Educator Network (GEN) is a teacher professional development program of the Astronomical Society of the Pacific (ASP), in partnership with the National Optical Astronomy Observatory (NOAO), the New Jersey Astronomy Center (NJACE), and the National Earth Science Teachers Association (NESTA). GEN was funded by a NASA EPOESS grant from 2011 to 2014.

GEN grew out of the Galileo Teacher Training Program, and leveraged the Project ASTRO National Network in the development and piloting of the program in its first year. The program employs a train-the-trainer model designed to prepare educators nationwide to design and deliver their own professional development workshop for teachers. GEN’s primary goals are to:

1. Help teacher educators and teacher professional development providers engage and educate teachers of astronomy (and general science), especially in grades 3–9, using effective instructional strategies and educational resources, with engaging and inspiring content.

2. Promote the effective use of NASA-developed and NASA-supported resources by teacher educators and teacher professional development providers, through integration of astronomy/space science content with Galileo-inspired science inquiry and exploration.

1.1. Essential GEN Components

There are five elements common to all GEN workshops:

- Galileo-related activities, examining astronomy content and/or science inquiry;
Investigations incorporating the nature of science, science practices, and cross-cutting concepts;

- NASA-developed and NASA-supported resources and science content;
- Fundamental concepts to meet curriculum goals; and
- Resources adaptable for use in the classroom.

The advent of the Next Generation Science Standards made the program especially timely. The GEN program included significant time for participants to reflect on how the nature of science and science practices were incorporated into investigations, including how to adapt existing content and modify pedagogy for student engagement.

2. GEN Professional Development Institutes

GEN project team members conducted annual Professional Development Institutes (PDIs) composed of educators recruited from throughout the country. The selection committee gave priority to educators with prior experience in delivering teacher professional development, and a background in astronomy. During the two-day PDIs, participants learned how to design and deliver their own professional development for teachers in their local communities. At the end of the event, educators became certified as GEN Fellows. Each GEN Fellow committed to conducting a 15-hour professional development (PD) to at least 15 teachers in his or her home region.

During the Institutes, Fellows: (a) actively engaged in astronomy investigations; (b) reflected on best practices; (c) learned about how to adapt existing activities to emphasize science practices and the nature of science, and (d) improved their skills in designing learning experiences for their fellow educators. They also received GEN-related materials, including 20 copies of the NASA-funded *Universe at Your Fingertips* 2.0 DVD-ROMs, to use in their PD workshop.

3. Outcomes of the GEN Program

To gauge its effectiveness, the GEN program incorporated three types of evaluation:

1. An end-of-workshop Impact Survey administered to GEN Fellows at the end of each PDI, and by participating teachers at the end of each local PD;

2. An end-of-workshop Implementation Survey completed by GEN Fellows at the end of their local PD; and

3. An end-of-year Follow-up Impact Survey to both GEN Fellows and teachers who participated in a local PD.

3.1. Positive Impacts

Our surveys have documented the GEN program’s numerous successes. Over the past three years, 339 teachers have participated in 27 PD workshops put together by GEN Fellows. We estimate that approximately 23,500 students have been directly affected by the workshops.
Participants responded very positively to the workshops, rating their content and pedagogy on end-of-program surveys (Table 1).

<table>
<thead>
<tr>
<th>Statement</th>
<th>Mean (Max = 4)</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>There was adequate time to reflect on my learning experiences.</td>
<td>3.68</td>
<td>0.28</td>
</tr>
<tr>
<td>The exemplar investigations were effective models of science practices.</td>
<td>3.76</td>
<td>0.24</td>
</tr>
<tr>
<td>The exemplar investigations were effective models of reflections on the nature of science.</td>
<td>3.79</td>
<td>0.26</td>
</tr>
<tr>
<td>The information and skills I learned in this PD are transferable to other science disciplines besides astronomy.</td>
<td>3.77</td>
<td>0.23</td>
</tr>
</tbody>
</table>

To track perceived learning gains, we asked educators to rate their knowledge before (retrospectively) and after the workshop on a scale from 1 (none) to 5 (complete). Participants grew the most in their awareness of NASA resources, but also gained substantial ground in their ability to teach with investigations (Table 2).

<table>
<thead>
<tr>
<th>Statement</th>
<th>Mean Gain (Max = 4)</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science practices</td>
<td>0.99</td>
<td>0.30</td>
</tr>
<tr>
<td>The nature of science</td>
<td>1.00</td>
<td>0.30</td>
</tr>
<tr>
<td>Using investigations to teach science practices</td>
<td>1.21</td>
<td>0.36</td>
</tr>
<tr>
<td>Using investigations to teach the nature of science</td>
<td>1.16</td>
<td>0.29</td>
</tr>
<tr>
<td>Using investigations to teach astronomy</td>
<td>1.38</td>
<td>0.37</td>
</tr>
<tr>
<td>Availability of NASA resources</td>
<td>1.48</td>
<td>0.47</td>
</tr>
</tbody>
</table>

3.2. Implementation Challenges

While educators praised the GEN PD workshops, the Fellows encountered some obstacles when bringing those events to fruition. These included:

- Finding local partners and venues;
- Recruiting participants;
- Acquiring additional funds and resources;
- Submitting evaluation data; and
- Balancing time commitment with other professional responsibilities (this was more of a challenge for GEN Fellows who were also classroom teachers).
3.3. Educators’ Use of GEN Workshop Activities and Pedagogical Strategies

In June 2014, evaluators distributed a follow-up survey for teachers who had participated in their GEN PD workshops from the 2013 summer through the 2013–14 school year. Teachers answered questions about what they remembered from the workshops, and what activities, resources or pedagogical strategies they had used in their classrooms that year. 70 educators responded, representing 30% of eligible participants.

81% of the respondents indicated that after the workshop, they had taught lessons about the nature and practice of science. Nearly as many (79%) had shared information from the workshops with others. When asked about their experiences implementing GEN workshop lessons, they offered the following reflections:

- My students are asking more questions and also referring to their data to answer them.
- Students were hesitant since there was no “right” answer. With more practice students enjoyed the activities and were more engaged.
- The lessons went well and encouraged students to collaborate and create justifications. The students struggled at first and experienced some frustrations however they overcame these and got used to the new format.
- The students were more engaged as my level of comfort increased.
- The students struggled but in a good way. They enjoyed the thought process and the hands on participation. However, they struggled on how to adapt when things didn’t go the way they planned.
- Students liked making their own observations and coming to conclusions based on those observations.

4. Conclusions

Collectively, our evaluation efforts have documented the ways in which the GEN project is achieving its goals of (a) conducting outreach to science teachers in grades 3–9; and (b) promoting the effective use of NASA-developed and NASA-supported resources. Survey data suggest that GEN project leaders and Fellows have successfully developed and facilitated a series of activities that have engaged educators in the nature and practices of science. Perhaps more importantly, workshop participants have been able to share what they’ve learned with their students and fellow teachers.

Acknowledgments. The authors wish to thank the following for their contributions to the success of the GEN program: Wil van der Veen and Theresa Moody from the New Jersey Astronomy Center at Raritan Valley College; Stephen Pompea and Rob Sparks at the National Optical Astronomy Observatory in Tucson, Arizona; the Adler Planetarium, and the Orlando Science Center for hosting the 2012 and 2013 PDIs, respectively; and all the GEN Fellows and participating teachers who implemented the content and pedagogy, and contributed their data to the project.