The Impact of an Authentic Science Experience on STEM Identity: A Preliminary Analysis of YouthAstroNet and MicroObservatory Telescope Network Participant Data

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Synopsis
In this astronomy education program featuring robotic telescopes, pre-post changes in youth participants’ science affinity, STEM identity, and STEM career interest are modeled to measure impact of core program elements. These elements are designed to support authentic inquiry: e.g. requesting images with robotic telescopes; using image processing software to enhance and make measurements of images; asking questions; connecting science to everyday life.

Introduction
Encouraging students to pursue careers in science, technology, engineering, and mathematics (STEM) is a high priority for national K 12 education improvement initiatives in the United States. From both equity and workforce demand perspectives, the fact that females and students of color continue to be underrepresented in STEM pursuits is particularly worrisome.

Authentic Inquiry
Many educators have claimed that a promising strategy for nurturing early student interest in STEM is to engage them in authentic inquiry experiences. An “Authentic” refers to investigations in which the questions are of genuine interest and importance to students, and the inquiry more closely resembles the way real science is done. The YouthAstroNet program is designed to put this theory into action.

YouthAstroNet Project Goals & Program Design

- Create and study a nationwide online learning community and program that features the remotely-controlled, online MicroObservatory telescopes of the Harvard Smithsonian Center for Astrophysics
- Increase the interest and positive dispositions of middle school youth, especially girls and underrepresented youth, toward STEM and information technology careers

Essential Program Design Elements:
- Online community supporting interactions among students, educators (PD), project staff, and STEM professionals
- Personalized access to robotic telescopes, online workspace
- Use of professional image analysis tools and techniques to pursue projects of interest
- Adaptable hands-on activities focusing on concepts in astronomy, digital imaging, light & color, etc.

Methods and Study Group

Development of pre/post survey instruments: Through pilot-testing and factor analysis of an initial research-based instrument, we identified items that measured 6 hypothesized underlying factors that might be affected by student STEM learning experiences, or have an influence on student outcomes including STEM career interest. 3,4,6

Fig 4. Factor analysis of pilot items.

The final pre-post surveys were constructed from a subset of items within these factors, plus demographics. The post-test instrument also included an extensive set of questions that asked about the kinds of instruction and learning activities that students experienced as part of their program.

Results, Continued

However, after accounting for students’ different program treatment experiences and for their prior attitudes and interests via regression models, a predictor of significant student gains in Affinity, STEM Identity, Computer/Math Identity, and STEM Career Interest could be identified. This was the degree to which students reported using and experiencing the primary “authentic” learning activities of the YouthAstroNet program (Table 1). These core activities—which included requesting robotic telescope images, using image processing software to enhance and make measurements of images, asking questions, and connecting science to everyday life—emerged together as one of three correlated groups of treatment variables in a factor analysis of student responses regarding their experience of 34 different potential program instructional strategies.

Table 1. Results of regression main effects models predicting pre- post changes in student STEM attitudes and astronomy knowledge.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficients (SE)</th>
<th>Constant (SE)</th>
<th>Effect Size (Change in units of SD from Pre-Test to Post-Test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interception</td>
<td>-1.00(0.21)</td>
<td>0.50(0.02)</td>
<td>0.50</td>
</tr>
<tr>
<td>Student Impact</td>
<td>0.12(0.04)**</td>
<td>0.00</td>
<td>0.12</td>
</tr>
<tr>
<td>Computer/Math Identity</td>
<td>0.18(0.07)**</td>
<td>0.00</td>
<td>0.18</td>
</tr>
<tr>
<td>STEM Identity</td>
<td>0.11(0.07)</td>
<td>0.00</td>
<td>0.11</td>
</tr>
<tr>
<td>Astronomy Knowledge</td>
<td>0.03(0.04)</td>
<td>0.00</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Implications and Future Analysis

Most of the educators of the students in this analysis were brand new adopters of the YouthAstroNet program model and first-time users of the MicroObservatory telescopes and image-analysis procedures. These preliminary results may suggest that the degree to which educators can integrate the primary authentic inquiry innovations of the project into their instruction can have a direct and positive effect on student outcomes.

The preliminary analysis is limited because many potential factors and project data sources have yet to be incorporated. These include an exploration of educators’ pre/post survey data including their professional development and implementation experiences; an analysis to determine if there is a differential impact on specific demographic groups; and hierarchical linear modeling to examine specific program characteristics, such as duration, in- or out-of-school settings, single vs. mixed gender groups; and analyses that incorporate embedded analytics of participants’ online participation.

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