# Preservice Teachers' First Experiences Teaching Astronomy: Challenges in Designing and Implementing Inquiry-Based Astronomy Instruction for Elementary Students in After School Programs

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## CONCLUSIONS

Creating opportunities for children to participate productively in scientific inquiry requires teachers who are knowledgeable about: the content, practices of inquiry, and specific methods of doing inquiry in the target domain. Developing and enacting inquiry in astronomy presents several challenges for elementary teachers because of their limited content knowledge (e.g. Brunsell & Marcks, 2005) and their limited understanding of scientific inquiry (e.g. Lederman et al., 2002). This study investigated challenges faced by preservice elementary teachers as they designed and implemented extended astronomy inquiry investigations with children in an afterschool program.

Most preservice teachers created at least one inquiry-based investigation. Most were able to construct ready-to-investigate questions, many engaged students in using physical and kinesthetic models to explain observations, and some created supportive environments for data collection in ways that did not require first-hand observations. However, few pairs were able to create an investigation that spanned more than 2 lessons. Analysis suggests the following possible explanations:

* Many began with imited knowledge of astronomy
* Some did not understand how to go from an investigation question to collecting/analyzing data
* Limited knowledge of how to engage children collecting and analyzing data in afterschool program
* Even when data was available, some teachers still relied on presenting students with "the correct answers"
* Emphasized answering fact-based questions rather than constructing explanations using evidence

## References


Brunsell, E., & Marcks, J. (2005). Astronomy Education Review. 3(2): 38-46.

FOSS (2007). Sun, Moon, and Stars. Lawrence Hall of Science, Berkeley, CA.

Lederman, N. G., Abd-El-Khalick, F., Bell, R. L., & Schwartz, R. S. (2002). Journal of Research in Science Teaching, 39(6), 497-521.

NRC (2000). Inquiry in the National Science Education Standards. Washington, DC: National Academies Press.

**Content Assessment References:**

Astronomy Diagnostic Test 2.0 (Collaboration for Astronomy Education Research, 1999, http://solar.physics.montana.edu/aae/adt/)

MOSART: Misconception Oriented Standards-Based Assessment Resource for Teachers (Sadler et al., 2011, cfa.harvard.edu/smgphp/mosart)


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## Purpose and Research Questions

The purpose of this study was to investigate the strategies preservice elementary teachers used to implement astronomy instruction to afterschool programs. The goal is to uncover the specific ways they integrated astronomy content goals with inquiry-based instruction.

1. To what extent were preservice elementary teachers able to create extended inquiry investigations for elementary astronomy topics?
2. What challenges limited the success of their attempts to create these extended inquiry investigations?

## Methods

**Participants**: Preservice teachers (N=30) from three elementary science methods courses taught by J. Plummer and co-taught by another science education professor. The students included undergraduate juniors (N=19) and post-bac certification students (N=11). All but one student was female.

**Methods course:**

***Week 1-5:*** Students studied astronomy through inquiry-based experiences; read an elementary astronomy curriculum (FOSS, 2007). The professor used this experience as a foundation for discussing inquiry-based pedagogy (e.g. NRC, 2000).

***Week 6-10***: Pairs of teachers taught small groups (3-10) of children, once a week, in after school programs. Assignment: teach an extended inquiry investigation on astronomy. Children ranged from K– 6th grades.

***Week 11-15:*** Students reflected on their experience and developed a new investigation (on any science topic) for their final culminating project.

**Data collection and analysis**

Data analyzed included a MC content knowledge assessment and five lesson plans written by the pairs. T-tests were used analyze improvement in content knowledge. A coding scheme was developed to analyze the use of inquiry in the lesson plans based on criteria presented in box to the right. Analysis of nine pairs (N=18) of undergraduate preservice teachers is presented.

## Results

### Pre/Post Concept Assessment

Analysis of the 24-item content assessment suggests that the in-class activities and experience designing and teaching astronomy improved their knowledge of astronomy, though most still had non-normative ideas about some topics.

**Table 1:** Pre/post content assessment results

| Content assessment | Pre-test mean and SD (N=30) | Post-test mean and SD (N=30) | t-test results |
|---|---|---|---|
| All items | 8.8 (2.9) | 13.8 (3.2) | T=9.437, p<0.001 |

## Results, continued

**Table 1** - Examples of investigation questions proposed by preservice teachers

| Teachers | Question(s) | Leads to evidence and explanation |
|---|---|---|
| Carly & Claire | How and why does the sun move? | Yes (4.5 lessons) |
| Beth & Belinda | Why do we have day and night? | No (2 lessons) |
| Alisha & Adina | How/Why does the sun move? | Yes (3 lessons) |
| Flora & Fran | How does the shape of the moon appear to change and why? | Yes (1 lesson) |
| Gina & Gwen | Why do the sun, moon, and stars appear so small in the sky? | No (3 lessons) |

**Table 2** - Examples of evidence used by the pre-service teachers in their lessons

| Teachers | Investigation question(s) | Data source |
|---|---|---|
| Carly & Claire | How and why does the sun move? | Students gave teachers instructions to observe and draw sun's location at 5 times during a day |
| Gina & Gwen | Students will investigate the apparent movement and direction of the sun, moon, and the stars. | Students observed daily motion in Stellarium, learned cardinal directions using a compass, then returned to observe Stellarium again |
| Dana & Diana | How does the sun appear to move? | Students recorded the time and location of their observation of Sun in Stellarium in a chart in their science notebook |

**Table 3** - Examples of methods the teachers used to support students constructing explanations

| Teachers | Investigation question(s) | Scaffold |
|---|---|---|
| Flora & Fran | How and why does the shape of the moon appear to change? | Teachers lead students through modeling phases with balls and lamp; limited connection to evidence |
| Dana & Diana | How does the sun appear to move? | Students created a representation (drawing) of the sun's path using evidence (their observations of Stellarium) |
| Alisha & Adina | Why do we have day and night? | Teacher guided students to kinesthetically model the earth's rotation as they observe the apparent motion of a sun-lamp. |

### Analysis of preservice teachers' development of extended inquiry investigations

**Criteria:** Investigation question leads to collecting or analyzing data presented by teacher;
Investigation question answered using evidence;
Explanation constructed, using evidence, in response to investigation question

**Table 5:** Continuum of teachers' use of extended inquiry investigations

**Limited use of scientific investigations** ⟷ **Sophisticated use of scientific investigations**

| | | | | | |
|---|---|---|---|---|---|
| May refer to lessons as investigations but do not meet criteria | Lesson(s) include investigation question(s) but does not lead to use of data | 1 or more lessons include an investigation question and evidence; limited explanation | Single 2-day lesson that meets the criteria | 3 continuous lessons meeting criteria | 4+ lessons meeting criteria |
| Eve & Erin | Beth & Belinda | Flora & Fran | Dana & Diana | Alisha & Adina | Carla & Claire |
| Heather & Hill | Gina & Gwen | | Ivy & Isabelle | | |