Scientific Habits of Inquiry in Research Environments (SHIRE)

Yuanyuan Zhang, Spencer Pasero, Ryan Plestid, Brian Nord

Building a research curriculum for students to learn essential research skills
Context: the Ecosystem of Education in Research

Introductory Research Experiences
- REU
- UROP
- SIST

North Star

Quark net

Development of Skills
- Code
- Speaking
- Lab

Curriculum
- Group Work
- Time Mgmt
- Synthesis
Specific issues and challenges for researchers

1. **Rabbit Hole**: Fear of not knowing if an approach will yield results
2. **Time Management**: Lack of skills in estimating time for a task
3. **Appearing Dumb**: Fear of asking questions
4. **Appearing Unproductive**: Avoiding conversations when experiencing problems
5. **Back of the Book**: Expecting answers to be found, not synthesized
6. **Imprecise Communication**: Quantitative and precise communication
7. **One Tool**: Expecting one tool to solve a problem
8. **Only Looking Out**: Lack of skill in viewing oneself in context
9. **Unfinished Business**: What does it mean to finish a project?
We piloted a research curriculum program with the Fermilab Quarknet Internship Program.

- 6 High-school interns.
- The students work with a Fermilab researcher for 6 weeks on a project.
- The research curriculum pilot, SHIRE, takes place in the first week.
- Thank you to the Fermilab Education and Public Engagement office for the support.

The Quarknet Cohort of 2015
A Four-day Pilot Program

<table>
<thead>
<tr>
<th>Day</th>
<th>Theme</th>
<th>Activity</th>
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</thead>
<tbody>
<tr>
<td>Day 0</td>
<td>Internship orientation (not part of SHIRE)</td>
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<tr>
<td>Day 1</td>
<td>Defining the Research Problem</td>
<td>Strong lensing questions in research</td>
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<td>Day 2</td>
<td>How to read a paper</td>
<td>Reading papers about strong lensing science</td>
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<td>Day 3</td>
<td>Navigating the Research Process</td>
<td>Methods for finding strong lenses</td>
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<td>Day 4</td>
<td>Communicating Effectively</td>
<td>Communication methods and exercises</td>
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Instructors:

Benjamin Aleman (guest lecturer), Brian Nord, Ryan Plestid, Spencer Pasero, Yuanyuan Zhang.
Sample day: Day 3 “Navigating the research process”

Goals:
- Students learn about the basic process of working on a research problem, and the necessity of going into rabbit holes.
- They understand the need to break down a big problem into workable bits, going to the bits in depth, learn about the limit in those in-depth explorations, summarize and refine plans.

Learning activity based on: A strong lensing classification problem
Main activities

- A beginner’s visual classification exercise of strong lenses.
- Digestion and discussion to generate ideas for improvement.
- Read a research paper about strong lens classification methods.

**Afternoon**

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"The beginner’s exercise was important to figure out what we didn’t know about."
Sample day: Day 3 “Navigating the research process”

**Highlights**

- **Metacognitive review**: share with us what you have learned. How do you view failures? How will you approach a research project in the future?
- **Panel discussion**: scientists talking about their experiences with failures, unproductive days and rabbit holes.

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“We’d like more of the panel discussion.”
Summary

- We implemented SHIRE, a 4-day research curriculum that covers the training of soft research skills.
- Program takes place in the 1st week of the Quarknet summer internship program.
- We think the students learned something from this!

Future Directions

- Quantitative analyses of the impacts of the curriculum.
- Incorporate more aspects of research skills.