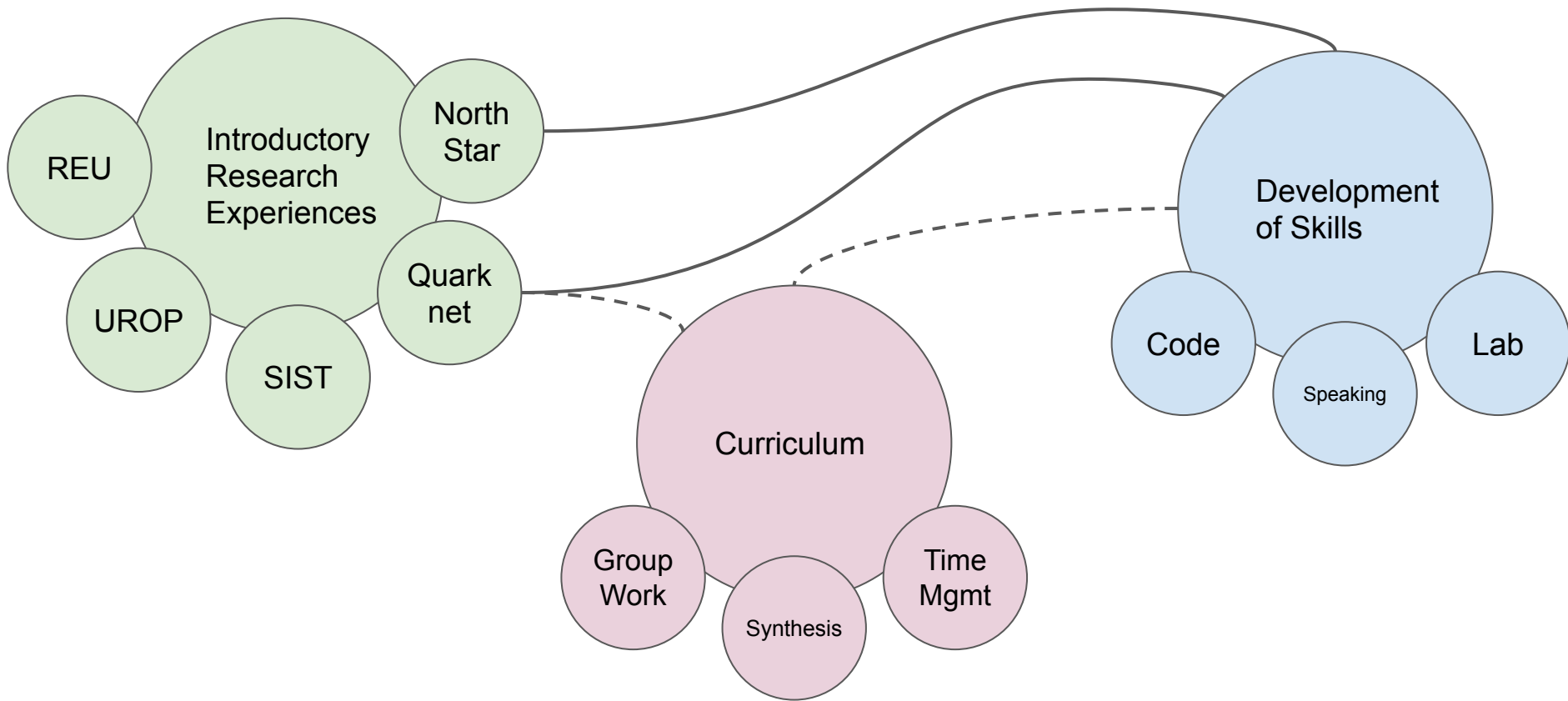


Scientific Habits of Inquiry in Research Environments (SHIRE)

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



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

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

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



Sample day: Day 3 “Navigating the research process”

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.

“The beginner’s exercise was important to figure out what we didn’t know about.”

Afternoon

1:00	Literature study about strong lens classification
2:30	Discussion of the papers
3:00	Break
3:15	Metacognitive review
3:45	Break
4:00	Panel discussion on navigating research process including failures, rabbit holes
5:00	End of Day

Morning

9:00	Preview of the day
9:30	Strong lens classification exercise
10:15	Break
10:30	Guided discussion of the exercise
11:00	Improving the process
12:00	Break for lunch

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.

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

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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.