

# Understanding the Impacts of a Solar Physics/Astrophysics REU on Undergraduate Students



R. Fleming – Montana State University, Bozeman, MT – Summer, 2025

## Background and Literature

### The Program:

MSU Physics has hosted a Solar Physics/Astrophysics REU the last 23 years. This past year, the program received 7 students from across US places of higher education (Montana State University Solar Physics, 2024). The REU is structured using research mentors and courses to further student education. Classes at the beginning of the summer are physics-based with extensions into applicable fields. Courses shifted toward professional development as the summer progresses.

### Focus Question:

How does a summer research experience for undergraduates (REU) impact students?

- Sub questions:
  - How will outreach experience impact student confidence and public/science interactions?
  - Can the MSU Solar Physics/Astrophysics be improved through observations gathered through formative assessments and student success?

### Formative assessments:

As science evolves, so too does science education. Formative assessments are in place to monitor student progress in class or other endeavours and allows for almost real-time changes to benefit students and educators.

### Methods:

- Three pronged approach: student betterment, impact of outreach, program improvement
- Formative assessments utilized
- Outreach component reintroduced
  - Bozeman Young Men's Christian Association (YMCA)

### Class based and Improvement assessments:

- Self-confidence Likert Type Survey
  - Conducted at entrance, midway, and exit
- Chain Note assessments during or after lecture about the class
- Comparison between this year and previous years exit survey conducted by the PI of the REU, Dr. Jiong Qiu
- Student Journal Submissions

### Professional development assessment:

- Direct Paraphrasing
- Researcher Observation of Presentations
- Student Interviews



Figure 2: This graph depicts the REU Exit Survey results from 2015 - 2024 with data gaps in 2019 and 2020 (indicated with the dashed line). There are 14 total questions asked and divided into categories: experience, academic, research, and orientation. Please note that graphed lowest score is 1.8 and not 0.

## Results of Assessments and Observations

### Student Self-Reported Outcomes

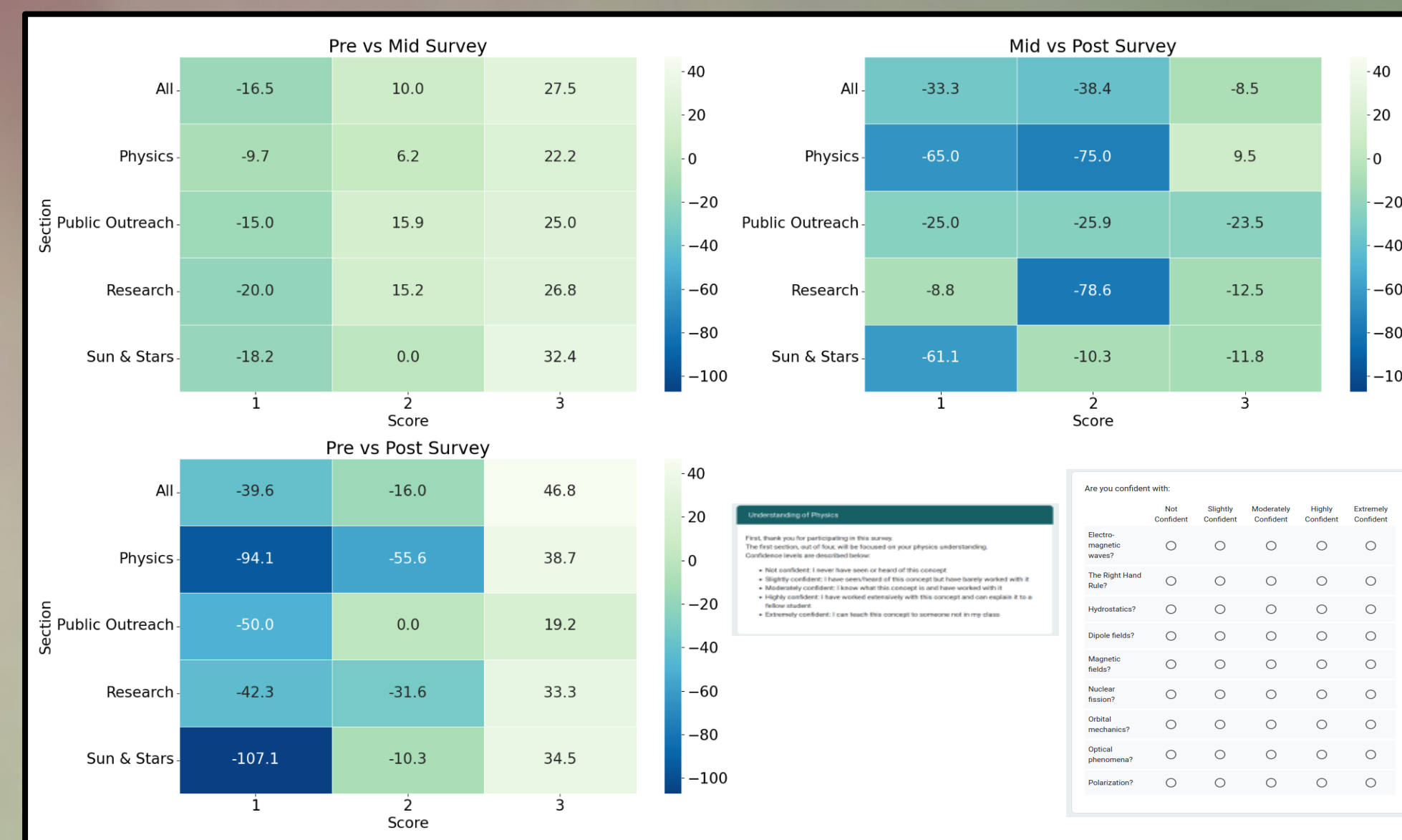


Figure 1: Featured are three heat maps and sample question of the self-confidence likert survey ( $N=7$ ). Each is a normalized gain comparison between assessments 1, 2, and 3.

### Self-Confidence Assessment (Above)

- Surveys covered four topics: physics concepts, Sun and star concepts, research experience, and public outreach experience
- Analysis: "not" and "slightly" confident (score 1) were combined, "moderately" confident remained untouched (score 2), and "highly" and "extremely" confident (score 3) were combined
  - normalized gain (figure above)
  - chi squared analysis, were then run

### Results:

- Paired T-test results from pre- to post- survey were statistically significant in public outreach
- As students progressed, score 1 responses had high negative scores showing an increase in confidence
- The greatest shift in confidence was in Physics and Sun & Stars content, aligning with REU program goals

### REU Exit Survey (Left)

- Scores from 2015 - 2024 with a gap for years 2019 and 2020
- The same 14 questions were asked throughout this time
- Students report responses from 0 to 3 with 0 being the worst score and 3 being the best.

### Results:

- The average score shows a decrease in satisfaction from previous years
  - A contribution could be the number of responses ( $n=6$ ) unlike the normal 8 student responses.
- Students craved a greater sense of community



Link to all data collection instruments and dates

References: Montana State University Solar Physics. (2024). MSU Solar Astronomy & Space Physics REU Program. <https://solar.physics.montana.edu/reu/>



### Reacher Analyzed from Student Response

### Chain Note Assessment Results

- Given during three lectures and focuses on student interaction with the material/professor
- Each question assessed for similar responses and notable comments from students



Professor Feedback: energetic and passionate about the subjects they teach

### Class Feedback:

- Materials presented with visuals were more impactful than a slide of equations
- The material covered higher level electromagnetic field courses than the students' have studied
- Students were willing to educate themselves during the lecture on terms and basic concepts



### Student Review:

- Students were more inclined to focus on research than on the lecture itself during presentation weeks
- Students noted stress before the presentations
- Increase lectures (from 8 to 10) and leave Thursday lecture before presentations for practice session

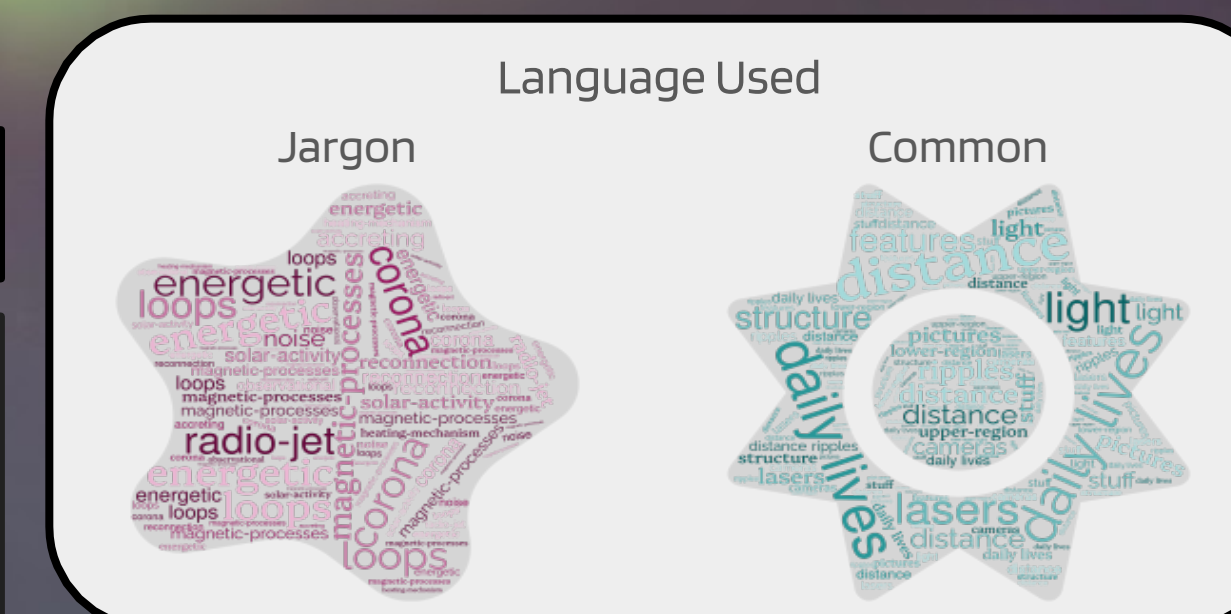


Figure 3: Two word bubbles illustrate the difference of language used by students ( $N=7$ ) during the direct paraphrasing assessment. The left hand star details jargon terms, or field-specialized terms. On the right, during a later direct paraphrasing assessment, is common language used to explain the same science as the star.

### Direct Paraphrasing Results (Above)

- Given twice, once after first professional development course and once before visiting the YMCA
- One of the strategies tracked student professional development
- Presentations were given to fellow students and advisors
- Students visited Bozeman YMCA to present their research to a younger audience

### Result:

- Clear student improvement after coaching and presentation practice: 5 standard words to 2 jargon words
- Jargon words turned to simplified, but helpful language

### Final Thoughts and Observations

Student response from classes is clearly illustrated above, however, some final thoughts can be presented and related back to the self-confidence survey. Specifically, student response to interviews after taking outreach/public speaking classes, presenting over the duration of the REU, and visiting the local YMCA and interacting with children (estimated 7-12 year olds). Giving students the opportunity to interact with local community was impactful on the students and was mentioned as such by all four of the student interviewees.

"This is something I would have loved to have as a kid, but I never got that opportunity because there was not a whole lot of like outreach like that back when I was a kid." – Direct student quote

Student evolution in presenting science was also seen during group presentations as confidence improved visibly and reportedly by student interviewees.