

ACT Undergraduate Research Experiences - 2015-2017

1 Introduction

During the 2015-2017 funding cycle the ACT collaboration has continued its strong record of training undergraduates for careers in science. During this period we have broadened our summer research program to include more students from under represented groups (see statistics in section 2). Our program has done more than simply mentor undergraduate research projects. Indeed, in some instances we have provided students with experiences that have proven to be transformative; for evidence, see section 3. Building on these successes we intend to use feedback from past undergraduates to make our program stronger; section 4 describes the lessons we have learned and what improvements we plan to make in the future.

The ACT undergraduate summer research program is decentralized, with each of the collaborating scientists recruiting their own undergraduate students*. In the summer of 2016, there was a special program to bring all undergraduates participating in ACT-related activities together (some over the net) to get a bigger picture of the field of cosmology. This was supplemented by a cosmology crash course for the large number of Princeton summer students.

The information about the undergraduate researchers which appears in this report is collected in the following way. First, each ACT collaborator mentoring a student logs that student's participation in a collaboration-wide spreadsheet. At the end of each summer, all students listed on the spreadsheet are sent a followup survey which asks them about their experience.

**Note: As originally promised, Advanced ACT funding for these projects was supplemented by that from multiple other sources: Cornell Credit, NASA-ROSES, LSAMP, NSF Honors Fellowship, SURF, SRCCS, NSF-REU, PSURE, NSF-REU, Stony Brook Funds, Haverford Funds, CITA Funds, SPS summer internship program, GSFC summer internship, SRCCS, University of Toronto Funds, URECA Fellowship.*

2 Statistics

From 2015 - 2017 ACT scientists mentored 45 undergraduate research projects. These projects have been conducted at nearly half of the ACT collaborating institutions (12 of 26), by students from all parts of the world.

Demographics

ACT is committed to recruiting undergraduate students from all backgrounds and of all genders. As such, our undergraduate researchers makeup a diverse population. Twenty nine percent of the ACT undergraduate research projects were completed by women; of these young women, 27% were not US citizens. Overall, 29% of our undergraduate researchers are citizens of a country other than the United States.

Student Matriculation into STEM careers

A dominant majority of ACT undergraduate researchers have pursued or plan to pursue careers in STEM fields. In the follow-up survey, students were asked a series of three questions about their future plans. These questions, and their resulting responses are shown below.

1. *Have you completed an undergraduate degree in a STEM field?*
71% percent responded "In progress", 24% responded "Yes", and 5% responded "No".
2. *If you are still an undergraduate, what is the likelihood that you will pursue an advanced degree in a STEM field? Rank from 1-5 with 5 being extremely likely.*
The average of all the responses was 4.55/5. One student responded with 1/5, saying he will certainly not pursue an advanced degree in a STEM field, however he did comment quite positively about his experience (see section 3), and he is the co-author of an Astrophysical Journal paper.

3. *If you have completed your undergraduate degree, did you enroll in an advanced degree program in a STEM field?*

100% of the responding students who have completed a undergraduate STEM degree have since enrolled in an advanced degree program in a STEM field. Of the students with an undergraduate degree “In progress”, 85% responded “No, but I plan to in the future.”

3 Personal Statements

The positive statistics shown in section 2 are supported by statements made by some of our undergraduate researchers. In the followup survey, students were asked “In hind sight, do you have any general comments/thoughts or suggestions for future summer research programs?” Five selected responses are shown below.

- “I would just like to comment that my research experience at Cornell was fantastic and was absolutely the reason I decided to pursue graduate study in the same field.”
- “Everything went well, especially because I really felt that I actually have an impact on the development and maintenance of the ACT!”
- “I thought the experience working with Prof. Renee Hlozek was amazing, she was a very encouraging and insightful mentor who inspired me in my research. I learned extremely valuable skills during this project, which I have continued to use in the project that followed, and now starting graduate school.”
- “Overall the experience was wonderful, I’m grateful to have had this learning opportunity and the opportunity to have worked with such great people in the Niemack Lab.”
- “Although I did not pursue a degree in STEM, this summer research program was an incredible way to see “science in action” and gave me a greater understanding of the engineering necessary to produce the data I’d been working with at Haverford College.”

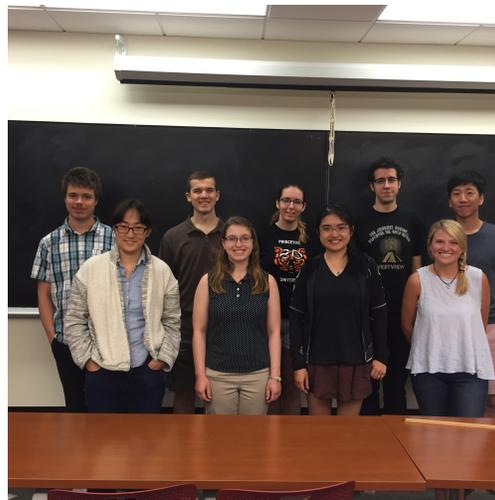


Figure 1: The photo above shows a mix of Princeton University undergraduate and graduate students. The first quote on the left came from Sarah Marie Bruno (front row, second from the left); she was an ACT undergraduate researcher at Cornell University and is now an ACT graduate student at Princeton University. The second quote on the left came from Georgy Noarov (back row, first on the left); he was a rising sophomore at Princeton University.

The quotes above are all very positive, and indicative of the $\sim 80\%$ of the responses which were similar. There were responses which were less positive, making up $\sim 20\%$ of the total responses. These had a common theme, that students wished to gain a broader perspective of the field and the collaboration. An example of such a response comes from a 2015 student: “More direct conversation with other cohorts would be beneficial for undergraduates to grasp the “big picture” of the project.” In the next section we address how we are using these comments to improve our program.

4 Assessment and Future Improvements

The feedback we have received from our students indicates many positive attributes about our summer research program. It has also shown us some places that we can improve in the future.

Successes

The statistics in section 2 and the comments in section 3 indicate that ACT undergraduate research experiences are very positive. Below we have identified three areas where we feel our program is particularly strong.

Pursuit of STEM Careers: Responses to our followup survey indicate that our program is at least affirming our students' desires to pursue careers in STEM fields and at most inspiring them to pursue these careers (95% of our undergraduate researchers either have enrolled, or plan to enroll, in an advanced degree program in a STEM field). These statistics, coupled with the anecdotal comments (see section 3) indicate that the students who do ACT-related research are quite likely to seek out advanced STEM degrees. This is clearly an area of success for the program.

Recruitment of Women: Another positive attribute of our program is our ability to recruit women. Our female participation rate of 29% is well above the enrollment of women at the bachelors and PhD levels (19% and 20% respectively for the class of 2015 according to AIP). Furthermore, 100% of the women who responded to our followup survey indicated that they have or intend to enroll in an advanced degree program in a STEM field.

Diversity: We have also done a good job of recruiting students from a large variety of backgrounds. In the followup survey, students were asked to (optionally) self-identify their race; the various responses were: White, Black, Asian, South Asian, Caucasian, and Middle Eastern. They were also asked to (optionally) self-identify their ethnicity and the various responses were: White Jewish, Caucasian-non hispanic, Iranian, White, Asian, Nepali, Canadian, American, Chinese, African-American, Indian, Hispanic, and Eritrean.

These points add up to give us great confidence that our undergraduate research program is drawing students from diverse backgrounds and that each student who participates in the program has a positive experience.

Areas to Improve

While our program has many strengths, it is clear that some areas can be improved. Below we describe the three areas which we have identified as needing improvement.

Recruitment: We have done a good job of recruiting a variety of minority and female students. However, we feel that we can increase the overall percentage of underrepresented students in our summer program. Of the students who chose to self-identify their race, 63% reported "White" or "Caucasian". In particular, we would like to increase the involvement of students who identify as "Black" or "African-American". From 2015-2017 10% of our students identified as Black or African-American; this number is much higher than the nation-wide bachelor and PhD degree rates (2.7% and 1.7% respectively, according to AIP). Nevertheless, we feel that our program has room to grow in this area. Though our female participation rate is higher than the national degree rates, we don't feel this number is high enough and we will continue to push to recruit more young women into the field of cosmology.

The Big-Picture: Our followup survey received multiple comments which indicated the value of a meeting/class/workshop to show students how their specific project fits into the ACT collaboration and the field of cosmology as a whole. For example, one student from the summer of 2015 indicated "More direct conversation with other cohorts would be beneficial for undergraduates to grasp the "big picture" of the project". Students that participated in the cosmology crash course at Princeton in 2016 indicated that it was very helpful for just this purpose. Other students indicated that the web meetings were also helpful in placing their work within the collaboration (a side note: while the web meetings were useful, the technical challenge of holding them greatly reduced their frequency). From these comments we can see that this part of the research experience is not uniform from year-to-year and across institutions. This is something that we will work to improve in the future (see the next section).

Assessment: As described earlier, our method of assessment consists of logging undergraduate researchers, sending them a followup survey, and comparing the results of this survey to our own expectations and national-average data. However, the process of writing this report has shown us that our methods and metrics could be improved. The next section describes our intended improvements.

Looking to the Future

In the coming years the ACT collaboration will continue to provide research experiences to undergraduate students. We intend to build on past successes while addressing the areas which need improvement.

Starting in the summer of 2018, we will run a new style of cosmology crash course. The course curriculum will be developed at Princeton and disseminated to each institution hosting an undergraduate researcher. At these institutions, junior scientists (post-doctoral researchers or graduate students) will teach the one-hour-per-week course. This will give all undergraduate researchers a better “big picture” view of cosmology and the role of their project while providing the junior scientists with hands-on teaching experience (though outside the scope of this report, training our junior scientists in this area is important to ACT scientists). The minimal time requirement of this course will allow us to accomplish our big-picture goal without distracting from the primary goal of the program, i.e. the research experience.

We will advance the assessment of our program by requiring that all undergraduate researchers take the Survey of Undergraduate Research Experiences (SURE). The SURE is a survey series which has been vetted by the education research community. Before starting their project, students will take a “Reflection” survey which has the goal of understanding what they expect to get out of their research experience. After completing their project, students will complete the SURE III survey which has the goals of seeing how their experience matched their expectations and how their experience affected their career trajectory. The goals of the SURE series are similar to the goals of our current assessment, but the implementation is more thorough.

5 Summary

The undergraduate research experiences of students working with the ACT collaboration from 2015-2017 have been overwhelmingly positive. ACT has hosted a large number of students who subsequently pursued careers in STEM fields, sometimes explicitly because of their experience(s) with the collaboration. While the program has been successful, there are areas we will continue to improve and ACT looks forward to implementing these improvements and providing students with outstanding research experiences.