might lead participants to feel isolated, the PIs and faculty at the host institutions implemented several measures:

1. A mechanism was put in place that enabled the REU participants to regularly communicate with one another through Canvas.
2. Ice-breaker and collaborative/competitive activities were conducted throughout the summer at the host sites.
3. As noted, a final face-to-face meeting was hosted at CWU, and field trips were funded using non-NSF funds from CURPA and CWU.
4. The PIs communicated at least weekly with the REU students, providing program updates and feedback.

Evidence that these measures were effective in addressing isolation can be found in the students' exit surveys. Asked what elements of the REU had the greatest impact or benefit, the fourteen participants of the program listed:

- "Social interactions with Mentor at the Host Institution" (mentioned 12 times),
- "Social interactions with Students at the Host Institution" (9 times), and
- "End-of-the-summer activity at Central Washington University" (9 times).

One student described her interactions with the REU faculty and students as the "best part of the research experience."

Seven of the fourteen participants entered the summer research interested in obtaining a PhD. By the end of the summer, 11 of the 14 students (79 percent) indicated such an interest. Although the desire to pursue a doctoral degree is neither the focus of our program nor necessarily an indicator of its success, it is indicative of students' increased confidence in their ability to perform research. It also suggests that a distributed REU is as effective in building students' confidence in their ability to do graduate-level work as is the more traditional single-campus REU.

Funded by National Science Foundation Award #1358879

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*A listing of Fermilab's summer research programs, along with information for both mentors and participants, can be found at <http://ed.fnal.gov/interns/programs/> (retrieved August 3, 2015).

doi: 10.18833/curq/36/4/19

Research Collaboration Creates Opportunities for High-Impact Undergraduate Research

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It is well known that authentic undergraduate research contributes to positive student growth by developing students' disciplinary knowledge, general critical-thinking skills, and broader career plans. In our disciplinary field, psychology, providing such high-impact experiences can be a challenge, particularly at smaller institutions with potentially limited access to resources such as appropriate study populations and technological expertise. Over 15 years, however, we have maintained an active collaboration—author Oakes at the University of California Davis and author Ellis at Grinnell College—investigating early development of cognition in infants and toddlers. We collaboratively—and often with our students—develop research questions, design experimental procedures, and create study materials. We collect and analyze data at both institutions, typically combining our efforts in presentations at conferences and published manuscripts.

This work is labor intensive and involves conducting in-lab assessments of infants' and toddlers' abilities. Students at both of our institutions, Grinnell College, a small liberal arts institution, and the University of California, Davis, a research university, have been directly involved in this cutting-edge research. Students at both institutions receive mentoring from both of us, sometimes in person (e.g., when Dr. Ellis and Grinnell students visit UC Davis) and sometimes via teleconference and e-mail. We leveraged programs at both institutions to create contexts in which undergraduate students participated fully in the research process from inception to completion, in order to create high-impact research experiences.

One example of a program we have utilized is the Mentored Advanced Project (MAP) program at Grinnell College. MAP provides the opportunity for Grinnell students to receive mentoring from both of us while engaging in a research project at one or both institutions. Over the years, this MAP experience has ranged from Grinnell students physically remaining on campus for the entirety of the experience while receiving joint mentoring locally and remotely, to Grinnell students participating fully in both labs by spending days or weeks in each laboratory, to Grinnell students spending the majority of their research time at UC Davis, while receiving joint mentoring from both of us during on-site visits by Dr. Ellis and remotely when we are in different locations.

In each iteration, students became immersed in the research process while interacting with both of us and with staff and students at UC Davis. Although we have not engaged UC Davis students in a similar formal program, the undergraduates in the UC Davis lab gain from these experiences through collaboration with Grinnell students and through working remotely and during on-site visits with Dr. Ellis.

In the summer of 2015, we mentored a Grinnell student at a distance. The student spent the summer at UC Davis, receiving local mentoring and supervision and also remote supervision from Grinnell (e.g., weekly go-to-meeting conference calls, daily on-line journals). As with all MAP students, while conducting her project under our joint mentorship this student gained a broad base of discipline-specific knowledge and skills. The student proposed and designed a project, used the resources at UC Davis to create study materials, acquired programming skills, and engaged in data acquisition. Importantly, because the UC Davis lab is a cooperative environment, the student worked closely with other undergraduates working in the lab. With local guidance from both of us during Dr. Ellis's on-site visit, the student processed and analyzed her data. Throughout the process, the student devel-

oped independence and self-confidence. She presented her findings at an event at Grinnell College and at the national meeting of the Cognitive Development Society.

This example illustrates the approach we have taken with all of our MAP students. Regardless of where students ultimately conducted the work, students worked within the parameters of our collaborative research program to interpret the primary literature, design experimental protocols, and write research proposals for projects that could be completed in our labs. Our laboratories at the two institutions are configured with identical equipment so that student research projects are transportable between the two institutions, and so that data collection can occur at both locations simultaneously, if necessary. Because our work involves teams of student researchers, our MAP students became fully immersed in laboratory research activities, contributing to the day-to-day activities in the labs. The Grinnell students gained valuable experience in the larger Davis lab, which has undergraduates, graduate students, postdoctoral scholars, and professional research staff. They acquired critical technical, data, and management skills, and developed a broad understanding of the diversity of individuals who contribute to the research process.

Because multiple studies are conducted concurrently in each location, and because the UC Davis lab is engaged in several grant-funded projects, students in the program became knowledgeable about the work of others. At the UC Davis lab, in particular, students helped conduct experiments on a range of infant cognitive abilities. They attended lab meetings and participated in the greater research community at the Center for the Mind and Brain. These experiences served to build students' intellectual curiosity, heighten their ethical sensibilities, develop their understanding of the depth and breadth of the field, and forge their understanding of the tight connections between research and application.

Moreover, when MAP students and the Grinnell faculty mentor were actively engaged in both locations, these experiences were particularly rich not only for the Grinnell students, but also for the UC Davis students and staff who interacted with them. Grinnell's open curriculum requires students' active engagement in the creation of their own individualized educational paths, and the MAP program selects students who are self-motivated and who have a strong desire for independence and self-sufficiency in their research program. UC Davis students, in part as a function of their experience at a much larger institution, may not have experienced the same level of educational autonomy expected of Grinnell students. Hosting Grinnell MAP students in the lab, therefore, provided an excellent model for the local UC Davis students. In

addition, UC Davis students gained exposure to a scholar (Dr. Ellis) who works in a different educational context than they experience at Davis, thus enhancing their understanding of the range of potential career paths in the field. All students learned to work collaboratively and cooperatively to conduct the research, to develop technical and quantitative skills, and to advance psychological research.

There are several challenges to developing a program like ours. The first is to identify an appropriate research context. We have been effective because we have a long-standing ongoing collaboration. Thus, although student projects were self-contained, they fit into a broader research context. This has allowed us to combine student work with other work for the purposes of publication, and it has allowed us to fully engage in the research at both institutions. The second challenge is to identify appropriate student projects. Although our collaboration provided a context for student projects, it can also inhibit students' exploration of diverse topics. Because our work is often tied to federal funding, student projects must address the aims outlined in those grant-funded projects. This can provide students insight into how research is supported, and about the constraints placed on the research process by external funding. However, because of these constraints, we have worked with students to come up with creative solutions for them to be able to insert their own ideas into a project that fits within the scope of our ongoing work. Finally, our success depends on having laboratories that are identically equipped. Even slight changes in equipment or software would mean that data from our two labs could not be combined. We constantly are vigilant to maintain laboratory equivalence.

In summary, our collaboration has created high-impact learning environments that develop undergraduates' intellectual curiosity, ethical sensitivity, independence, and self-confidence in the context of conducting authentic research. All Grinnell College students who have participated in our collaborative research currently are enrolled at Grinnell, are in formal research or fellowship positions, or are pursuing or have earned advanced degrees. Experiences in our laboratories set our students on a course for more challenging work and have served to positively shape their career trajectories.

doi: 10.18833/curq/36/4/20

Spreading High-Impact Practices from the Genomics Lab to the Entire College and Beyond

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In the 21st century, community colleges are emerging as the backbone of higher education in the United States. Nearly half of all undergraduates start their education at community colleges and the percentage is even higher for students from groups underrepresented in higher education. National Science Foundation (NSF) grants are valuable for developing high-impact practices by individual faculty at various institutions, including collaborations between community colleges and research institutions. However, these practices will not change the higher education landscape unless they are scaled up to spread across the institution and across multiple institutions. Here we describe our ongoing endeavor to expand a model from two NSF-funded programs and to identify critical components and strategies in this process.

The Community College Genomics Research Initiative (ComGen), an NSF-funded program, started as a collaboration between Bellevue College and the Root Disease and Biological Control Research Unit of the United States Department of Agriculture's Agriculture Research Service. The USDA scientists provided a small fragment DNA library, technical advice, and classroom visits. Students at Bellevue College (from first-year to those with PhDs) enrolled in a stand-alone research course modeled as a one-quarter, graduate school experience. Without lectures or textbooks, students got a first-hand experience in being a scientist, including conducting original research in genomics and analyzing primary literature. The ComGen model focuses on a "hands-on, hands-off" method: hands-on for students and hands-off for the faculty. This method encourages faculty to empower students to experience the ambiguity, failure, and recovery from failure that are inherent in research. The ComGen program has drawn national attention, being featured in *Science* (McCook 2011) and drawing an invitation from the White House to engage in a pledge to increase the number of students in science, technology, engineering, and math (STEM) fields.

While the stand-alone research course had substantial impact, the number of students reached was limited since the course was an elective that many students could not fit into their schedules or afford. To expand the impact of the ComGen pedagogy, we introduced critical components of the original course into the cell biology course for biology