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CUR Focus

A Centralized Undergraduate Research Database: Collaboration Between Institutional Research and University-wide Research Programs

Abstract

Universities, particularly large ones, struggle to capture undergraduate research activity and impact. It requires a strong campus collaborative environment to track, map, and assess student involvement in undergraduate research. The University of Central Florida (UCF) Office of Undergraduate Research partnered with the Office of Institutional Knowledge Management (the institutional research unit that provides information to facilitate and enhance decision making, strategic planning, and assessment) to develop a "data mart" to track and map undergraduate researchers. The goal is not only to understand the number of students involved but also to understand the impact the various types of experiences are having on students. UCF is a large research-intensive university, and this was the first attempt to characterize student involvement. One of the many strengths of this work is that the characteristics of the student researchers can be compared to the undergraduate population, an aid to strategic planning. This article will review the collaboration, including how it was developed, how it is maintained, and its future directions.

Under pressure to document undergraduate research, universities struggle to capture undergraduate research activity and its impact. Few models have been developed to systematically document undergraduate research activities at higher-education institutions. It requires a strong, collaborative campus environment to track, map, and assess student involvement in undergraduate research. The goal is not only to understand the number of students involved, but also to discover the impact of various types of experiences on students' development. Like many large research institutions, the University of Central Florida (UCF), a metropolitan research-intensive institution, has struggled with capturing student participation in research. And yet doing so is important because of growing evidence that undergraduate research is a high-impact educational practice for enhancing student success (Boyer et al. 2003; Kuh 2008). A growing body of literature documents the effectiveness of research-based approaches in supporting undergraduate learning, as well as creating opportunities for undergraduates to actively engage in both research and other avenues of scientific inquiry (e.g. Brewer and Smith 2011; Kenny et al. 2001). Additionally, students who engage in undergraduate research activities pursue graduate education and additional research at higher rates (Hathaway et al. 2002; Lopatto 2003; Russell et al. 2007); demonstrate higher retention rates (Nagda et al. 1998; Schneider et al. 2015); increase academic achievement and graduation rates (Bauer and Bennett 2003; Craney et al. 2011); and develop fundamental critical-thinking skills (Hunter et al. 2006; Kardash 2000; Lopatto 2007; Schneider et al. 2015).

In 2013, the UCF Office of Undergraduate Research (OUR) partnered with the UCF Office of Institutional Knowledge Management (IKM) to develop a data-collection process to track and map undergraduate researchers and present the resulting information in interactive, online data visualizations. IKM serves two major campus roles. The first is traditional institutional-research reporting (e.g., state and federal reporting, facilitating and enhancing decision making, strategic planning, and assessment); the second is to operate the Enterprise Decision Support unit (a technical team), which develops and maintains a data warehouse and business intelligence and analytics for UCF. IKM reports directly to academic affairs, and OUR is housed in the College of Undergraduate Studies, which also reports to academic affairs.

The collaboration was initiated by OUR, which was interested in improving its labor-intensive manual data-collection process. At the same time, IKM was looking for an opportunity to utilize a new business-intelligence dashboard tool to deliver useful data in an informative and user-friendly way. It took this collaboration a year and a half to deliver a sustainable system for the university stakeholders. Although the two units have been collaborating on this project since 2013, and program participants have been entering data into the system for two cycles, OUR has only recently started sharing the newly updated dashboards with the university community. The project is continuing to evolve and is currently entering its third phase, which will be described below in the "future developments" section.

Documenting Undergraduate Research

Determining how many students are involved in any high-impact practice can be challenging, especially at large institutions where programs and opportunities are located throughout the campus. "The Challenge of the Count" was the theme of the Spring 2012 *CUR Quarterly*, which reviewed

many of the metrics used to quantify participation, including surveys, credit monitoring or program counts, and self-reporting by students and faculty (reviewed in Blockus 2012). These systems are not mutually exclusive because campuses often employ more than one metric for their assessment purposes.

Campus-wide surveys are a common method of documenting high-impact practices. Surveys can be constructed to reflect the needs of, and resources contained within, specific institutions. This method includes surveys used nationally, such as the National Survey of Student Engagement (NSEE; Wilson 2012), which specifically asks students, usually graduating seniors, if they have "done" research. Campuses often develop their own surveys to learn more about undergraduates' research participation and experiences. One example is the University of California Berkeley Undergraduate Experience Survey, which is used to determine the approximate number of students involved in undergraduate research at UC Berkeley, as well as to examine the distribution of opportunities relative to specific populations with varying needs (Berkes 2008).

Credit or program counts is another method of tracking students' participation in high-impact opportunities. Credit monitoring is particularly helpful in regard to internships and service-learning enrollments because many of these programs have a course-enrollment requirement. Within the constraints of privacy laws, tracking involvement in this fashion is a matter of pulling data from the appropriate systems. However, in terms of undergraduate research, credit hours are not always a direct indicator of student involvement. An institution can request or require students to enroll in classes as a part of specific programs, but many student researchers are volunteers who are not represented in this metric (Wolanin 2003). Campuses also often count the number of students who participate in specific activities such as research showcases or thesis-writing programs (e.g. Wilson 2012; Pukkila and Arnold 2012; Webber et al. 2012). However, issues commonly occur when students participate in multiple programs within a given year, resulting in an overestimate due to duplicative counts.

Self-reporting systems using variations of self-reporting tools can also be used for data-mining purposes. In these systems, individuals are responsible for monitoring their own progress and maintaining up-to-date records of their activities. The Ohio State University has one such system—the Portfolio of Undergraduate Research Experiences (PURE)—in which undergraduates can report their involvement in research and related accomplishments. The information obtained by this metric can then be used to determine university-wide statistics, establish goals, and identify areas for improvement (Snow 2014; Cwern personal comm). Annual faculty reports can also be used to gather self-reported information on undergraduate research activities and accomplishments (Pukkila and Arnold 2012).

UCF's Centralized Undergraduate Research Database

The University of Central Florida's collaborative database project was its first attempt to characterize student involvement in undergraduate research through a centralized database. Prior to our collaborative work, the university used the credit-monitoring and program-count metrics to report on individual programs and opportunities, but it experienced issues with duplicate counts. It was difficult to define "undergraduate research" and who would be included in the "count." For the purpose of the research database, we used a broad definition of research, hoping to capture any student working with a faculty mentor on academic scholarship outside of the traditional classroom. Thus "undergraduate research" included academic scholarship, research, and creative work in all disciplines.

Currently, undergraduates involved with the following program categories are included in the UCF database: (1) structured research programs (e.g., honors theses, McNair Scholars); (2) research professional-development opportunities (e.g., campus showcases, travel funding); (3) independent research/independent study credit completed with a faculty member; and (4) paid opportunities from some external research-focused grants. The federal grant records are carefully reviewed and principal investigators contacted, when appropriate.

Twenty different program categories have been entered into the database for the 2014-2015 reporting period (Table 1). This number increases each year as program personnel learn about the collaborative effort. At the end of each academic year, campus-wide partners are given access to a portal in order to input data. During the development phase, IKM and OUR met with the campus-wide partners (Table 1) several times to discuss their data needs and interests. This collaboration was and continues to be truly campus-wide. Currently, nine different offices submit program data.

OUR had originally collected program-category data spanning three years and inserted it into one large Microsoft Excel spreadsheet. Two team members from OUR and IKM spent four months conducting an extensive data cleansing and validation process, in which the data were examined for missing values, applicability, and accuracy. This included reviewing entries that pertained to non-students, graduate students, or non-enrolled students, which were usually removed from the data set. One exception is summer students who re-enroll in the fall, since many students conduct research while not taking classes in the summer.

The next step involved collaboration with the UCF Central Information Technology (IT) Division, during which customized tables with information relating to research programs, faculty/mentors, and student participation were created.

Table 1. Overview of UCF Programs and Students in Collaborative Database

Program Code	Program Name and Department/Unit	Number in 2013-2014
BRS-BHC	Burnett Research Scholars-Honors College	9
EXCL-ISTEM	EXCEL Program-Initiative in STEM	72
GRANTS-OUR	Grants-Office of Undergraduate Research	17
HIM-BHC	Honors in the Major-Honors College	369
ICUBED-ORC	Innovation through Institutional Integration (ICUBED), YES, STEAM & STEM-Office of Research and Commercialization*	NA for given year
IDS	Independent Study/Directed Independent Research Courses-Campus-wide	867
LEAD-SDES	LEAD Scholars Academy-Student Development and Enrollment Services	15
LEARN-OUR	Learning Environment and Academic Research Network-Office of Undergraduate Research*	24
MCNAIR-AAP	Ronald E. McNair Scholars Program-Academic Advancement Programs*	36
PAID-ORC	Office of Research and Commercialization (External Grants)	320
PURE-COM	Program for Undergraduate Research Experiences-College of Medicine	11
RAMP-AAP	Research and Mentoring Program-Academic Advancement Programs	55
SURE-OUR	Showcase of Undergraduate Research Excellence-Office of Undergraduate Research (Poster only event)	349
SURF-OUR	Summer Undergraduate Research Fellowship-Office of Undergraduate Research	23
TRAVEL-OUR	Travel Awards-Office of Undergraduate Research	34
FGLSAMP	Florida Georgia Louis Stokes Alliance for Minority Participation-College of Engineering and Computer Science*	New in 2014-15
NACME	National Action Council for Minorities in Engineering-College of Engineering and Computer Science	New in 2014-15
RAMA	Research and Mentoring Activities-College of Engineering and Computer Science	New in 2014-15
CYES-AAP	Camp YES-Academic Advancement Programs*	New in 2014-15
CMPS-ISTEM	COMPASS Program-Initiatives in STEM*	New in 2014-15
	2200 Entries 1697 Unique Students 592 Unique Faculty	

*Denotes a grant funded program

The IT division also developed a data-entry system that would allow personnel in each partnering program to directly enter information on individual students. Each user in the nine offices is able to log into this data-entry system (i.e., OUR does not load non-OUR program data). This system also provides the capability to upload bulk data from text files for programs with more than 100 students.

Data are compiled annually beginning in July for the previous academic year, starting with the summer term and ending with the spring term (i.e., summer, fall, spring). Data collection is fairly simple as only four data points are required for each program entry: (1) student identification number; (2) faculty identification number; (3) semester (term) involved; and (4) program category. Thus, students and their faculty mentors are linked and distinguished by unique campus identification numbers.

IKM then developed a series of user-friendly data-validation programs that OUR can use to check for issues. IKM found that programs were submitting inaccurate data on occasion. Thus, OUR looked for (1) missing faculty information (i.e., corrected faculty IDs), (2) students not enrolled in their given research term and those students were removed unless it was summer term, and (3) students who were not undergraduates but were enrolled in a graduate program. This validation program also allowed OUR to check for the completion of data entry for all programs during the data entry time period. Any anomalies discovered are investigated and corrected by the OUR staff or removed with the assistance of the IKM office.

Developing the Data Mart, Dashboards

The next step in the process was to develop the Undergraduate Research Data Mart, a subset of the UCF data warehouse, to contain the information entered into the customized tables. Data were augmented by student enrollment information, obtained from the data warehouse maintained by IKM, for both the undergraduate research population and the entire university undergraduate population for the purpose of comparison.

One of the tables in the data mart contains the student and faculty information. The table is structured so that there is one record per student, per research program, for each term of participation in each academic year. Each student is linked with a faculty mentor and can have multiple mentors in a single program in a given term. The data provide information on student demographics, such as age, gender, and ethnicity, but also include enrollment demographics, such as program of study, research program, student type (e.g., freshman, transfer),

full-time/part-time status, academic year, and whether or not the student is the first member of the family to attend college (first-generation). This detailed table includes information about the faculty mentor as well, such as department and college appointment, which is used for tracking involvement numbers and percentages, by organization.

The Undergraduate Research Data Mart also includes numerous aggregate tables that contain pre-summarized information (i.e., the counts and percentages by the student and enrollment demographics). Having the data aggregated aids significantly in increasing ability to generate reports on demand, as the mathematical calculations do not have to be performed for individual requests.

The chosen medium for reporting the undergraduate research database is a dashboard tool created using SAS® Business Intelligence software. SAS® is a leading provider of statistical, analytical, and data-visualization applications. The dashboard interface is a single page or screen presenting a graphical snapshot of historical trends for undergraduate research in student and enrollment demographics via data visualizations, such as bar charts and line charts. The first dashboard, "Welcome," provides information about the database, in addition to image-driven navigation for accessing each additional dashboard.

Currently four data-driven dashboards are available to the UCF community and are accessed through the "Welcome" dashboard that describes the database:

1) Research involvement counts. This dashboard displays overall totals of student research participation by year, dating back to 2009-2010. In addition, the dashboard provides student-level and faculty-level tracking by offering drop-down selection menus for college, department, and program to show the annual trends of student and faculty involvement in undergraduate research.

2) General student demographics. This dashboard provides a comparison between students involved in undergraduate research and the entire university undergraduate student population, based on demographic information such as age, gender, ethnicity, and first-generation status by academic term. Drop-down menus are also available, which allow the user to navigate between terms and quickly adjust the information displayed in the charts in response to the selected time period.

3) Enrollment demographics. This duplicates the general student demographics page, but displays student information by academic level at time of enrollment (i.e., transfer or non-transfer), college, full-time/part-time status, and whether or not the program of study is a STEM (science, technology, engineering, and mathematics) discipline. An additional measure shows the percentage of students who have earned 60+ hours by the beginning of the term during which they are involved in research.

4) Research program performance. This dashboard presents annual trends in student participation by type of program (i.e., all 20 program categories can observe their own programs). There are several links available on this page that provide additional information about the undergraduate research population.

For example, the user can retrieve a listing of all research program codes (Table 1) and descriptions or a tabular list of all programs' annual statistics by clicking on the hyperlink within the dashboard. The ability to focus on a specific type of program is delivered through clickable bars in the chart. Users can click on a specific program type's set of bars, and the display changes to reveal student involvement information for that program type by student or enrollment demographics. The offered drop-down menu allows the user to select a different program and the display easily changes without having to navigate back to the previous page.

Results Generated from Centralized Database

A clear goal of our work is to determine how many unique (individual) students are involved yearly in undergraduate research (Table 1). However, through the data mart, we are also able to report the number of faculty members mentoring students at the college, department, and individual levels. As an example, we have provided data on the involvement of individual psychology majors and faculty members (Figure 1) in the fall of 2013. This can be done for each college and department on campus. For departments working to increase involvement, they can easily track participation down to the individual faculty member.

For each year, it shows how many students and faculty mentors are involved in research, although the yearly numbers may include some of the same individuals who participated in previous years (i.e., unique within year but not between years).

One of the many strengths of this work is that the characteristics of the student researchers can be compared to the overall undergraduate population (Figures 2-4). We have developed numerous ideas about the data set's potential to help with strategic planning. In the fall of 2013, for example, the first-generation undergraduates documented in our research population (26.7 percent) matched very closely the proportion of the entire UCF undergraduate population who were first-generation college students—27 percent (Figure 2). (In Figures 2-4, UCF means the entire UCF undergraduate population; UG RSCH means documented undergraduate researchers.) We also see similar trends with ethnicity (Figure 3).

Programs that work with first-generation and underrepresented students appear to be successful in providing research opportunities to these students (e.g., McNair Scholars,

LEARN; see Table 1).

We see fewer transfer students involved in research compared to their portion of the overall undergraduate population (Figure 4). Our university has a large transfer population, up to 45 percent of our student body. Of the UCF undergraduate students with 60+ credit hours in the fall of 2013, 62.4 percent were transfers, while only 35 percent of undergraduate researchers were transfer students. This has led us to put new resources into working with our transfer population. As opportunities and programs come and go, however, these trends are likely to shift so monitoring the data yearly is necessary.

Limitations of This Approach

As with any tracking system, there are limitations to this type of work. One clear limitation to the OUR database is the lag in available data. Centralized data lags from six months to a year and a half after the time of a student's participation in research. Data are entered during the summer for the previous summer, fall, and spring semesters. The OUR office reviews and validates the data throughout the fall semester. It is typically late in the fall semester before we have complete, validated data available for the previous academic year.

Additionally, even though we have numerous programs collaborating with us, we are not documenting all students involved in research since our work does not include volunteer student researchers, work-study students who may be involved in research, authentic course-based research, student awards and honors (e.g., summer programs, off-campus grants), and publications, and students who present at conferences off-campus who do not get funding from OUR.

We suspect that volunteers are the biggest component of researchers
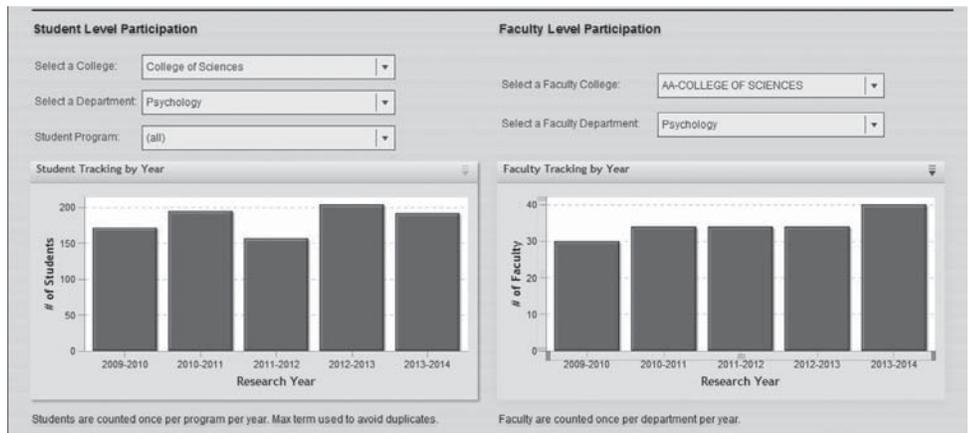
Figure 1. Example of Department-level Data

Figure 2. First-Generation UCF Undergraduates Compared with First-Generation Student Researchers, Fall 2013
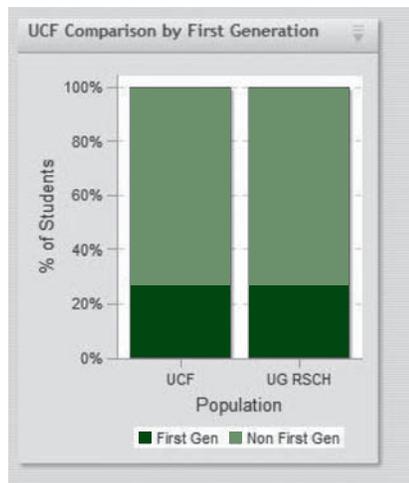

Figure 4. UCF Undergraduates with 60+ Credits in Fall 2013, by Type of Student, Research Involvement
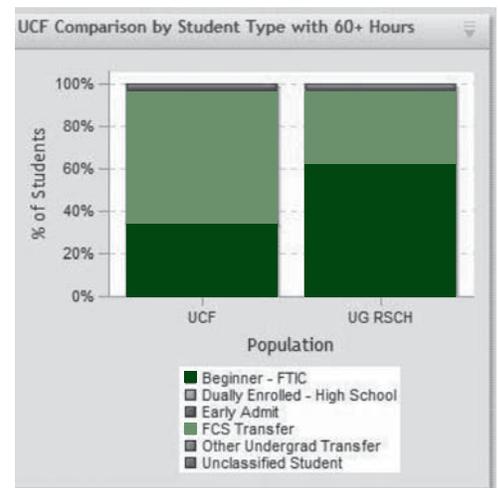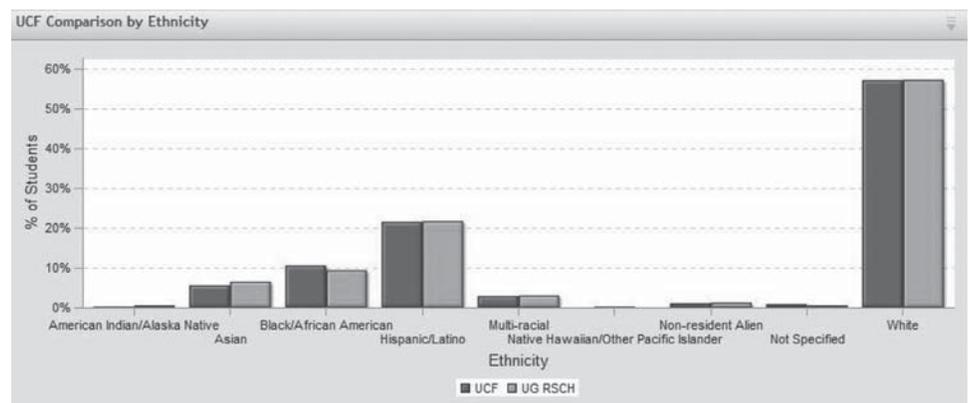

Figure 3. Ethnicities of UCF Undergraduates Overall Compared to Those of Undergraduate Researchers, Fall 2013

that we are overlooking. We have no way to document student volunteers working with individual faculty members, and we made the decision to not allow faculty to individually add their mentees to the data mart as that would give access to the system to many more users. Several years ago, UCF adopted a 0 credit hour option for our independent research credit. The 0 credit hour course shows up on students' transcripts and is free for students as long as they are enrolled in additional courses. It also formally documents the faculty mentor's work with said students and reduces liability. OUR actively works to promote this option to reduce the number of undocumented volunteer researchers. As the use of the database spreads, the hope is that the 0 credit hour course option will be used more frequently.

We also do not document students working with the federal work-study program on research projects. Again, through faculty awareness, we hope to increase the use of the 0 credit option for these students. Currently, we also are not tracking off-campus research that may occur in industry in the form of academic internships or summer research programs. These types of research may be added, when appropriate, to the database at some point.

Finally, we have no way of knowing what each student's individual research experience entails. For some programs, it is easy to determine the student's experience, however. For example, each year we have more than 300 students working on honors theses. These students have a defined experience with a thesis capstone. However, for independent research and independent-study credit, the experience for the student can vary greatly. Also, students paid from research grants can be doing a wide range of research, ranging from basic maintenance (e.g., washing laboratory glassware) to in-depth independent research programs.

Challenges and Future Development

As with any large-scale collaboration, we faced several challenges, including changes of staff and a need to work on other high-priority programs or projects within each unit. For example, IKM's original developer, who created the initial dashboard and supporting data tables, left the unit and the team's technical lead had to take over the project. OUR also is a very small office, and it experienced turnover during the project, and personnel were not able to work on the project at times due to other events. Further, the project experienced a delay of more than nine months due to a software upgrade that required complete redevelopment of the preliminary dashboard.

Some changes were made to the database, such as the nomenclature of the programs in the database (Table 1) and the definition of a research year. The research year (fall, spring, and summer terms) was changed to align with the university's definition of an academic year (summer, fall, and spring terms) and to reduce the amount of data manipulation required to finalize the annual statistics. This further impacted the delivery of the final system due to the labor-intensive ef-

fort required to recreate the database and dashboard objects using the new specifications.

The collaboration between OUR and IKM continues to strengthen as we plan new projects. Our future plans include moving into phase three of the project by adding retention and graduation rates for the students involved in undergraduate research, compared with the university's overall undergraduate population. We also plan to track students in the database after they graduate from UCF, using the National Student Clearinghouse to determine how many students involved in research matriculate into graduate programs. From retention, GPA, and graduate school matriculation data, we can look at differences among students in the database correlated to program involvement, length of involvement, disciplinary major, and other student characteristics.

Another new feature we are adding is reports of faculty mentoring. Utilizing the unique faculty ID stored in the OUR database, customized mentor reports will be developed that will provide detail on all the research (s)he mentored over the years. These reports can be used for tenure and promotion, teaching awards, grants, and so forth. This may increase faculty recognition for involvement in undergraduate research and create a systematic approach to give faculty credit for this type of work.

For several years, data have been made available to individual requesters, but now the dashboard is available to the UCF community. Starting in the fall of 2015, we were able to share data with individual departments about their documented involvement with undergraduate research. We hope that this will lead to faculty using the 0 credit-hour option more frequently and, thus, documenting more student and faculty involvement in undergraduate research campus-wide.

In addition, OUR and IKM are starting conversations with the College of Undergraduate Studies to replicate this program for other high-impact practices, including service-learning and academic internships.

Conclusion

The university's investment in creating an undergraduate research database is significant. Several hundred hours of staff time from both IKM and OUR were devoted to developing the data-collection and dashboard-reporting system. Each partnering program that inputs data into the system also has to take time to upload the information. However, as the processes are set in place and the learning curve declines, we expect the time required to decrease significantly.

The database has been used to provide data for federal and internal grant proposals, accreditation reporting, program reports, and strategic planning within departments and colleges. Moving forward, our goal is to strengthen the campus-wide system that will be frequently used by upper-level administrators, colleges, departments, programs, and individual faculty members. Through this strong partnership, we are showcasing the importance of undergraduate research at

our university. ◖◗

Acknowledgements

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