

Undergraduate Student Experiences at a Summer Research Fellows Program in Rochester Institute of Technology's Center for Student Innovation (CSI)

Stephen Jacobs, Interactive Games and Media

Jon Schull, Director, Center for Student Innovation

Carl Lundgren, Mechanical Engineering Technology

Kenneth Stewart III, Corey Mack, Justin Lewis, Elizabeth Keifer, Devin Hamilton, Eliza Hammer,
and Luticha Doucette, RIT undergraduates

ABSTRACT

In the summer of 2010, the Rochester Institute of Technology (RIT) rolled out a campus-wide summer undergraduate research program coordinated by the Center for Student Innovation (CSI). Students from colleges across the university worked with faculty mentors on projects that the students designed and led, covering the sciences, sociology, criminal justice, game design, and more. The diverse pool of student researchers included some from the National Technical Institute of the Deaf and the Louis Stokes Alliance for Minority Participation (LSAMP). All teams presented results at the RIT Undergraduate Research and Innovation Symposium. Faculty directors of the program will discuss its implementation and impact as a whole, while the students will discuss specific projects and their perceptions of the program. The projects they presented include a novel wheelchair design, a social network website for alternative energy projects, a new method for 3D visualization of proteins, an alternative for emergency housing, best practices research on the development of STEM educational computer games, and a game engine for Pygame and One Laptop per Child computers.

Introduction

RIT's undergraduate enrollment this past spring quarter was 11,981. The university is comprised of eight colleges and other small academic units, and offers over 200 distinct degree programs covering a wide variety of technical and artistic interests and skills. It is a potentially fertile environment for creative interactions among the disciplines, but a "strong college model" and the abundance of degree programs makes it challenging to bring this potential diversity together. When RIT's new President, Dr. William Destler, assumed his position in 2007, he committed the university to becoming "The Innovation University" and initiated a campus-wide inventory of innovation and creativity assets and opportunities. The current strategic plan includes the goal that "RIT will provide opportunities for 100% of its students to experience innovation, creativity, and scholarship by 2012." The Center for Student Innovation (CSI), a round glass building on a campus comprised of brick boxes, was opened in spring 2009 to provide a "silo-free" meeting and work space with the goals of stimulating and facilitating interactions between students, staff, faculty, alumni, business, and local innovation community groups. The CSI is meant to be an important part of the university's "innovation ecosystem," and in just over a year of operation, this 10,000 square foot facility has become both a symbol of RIT's aspirations and an active center for collaborative innovation. Exemplary projects housed in or affiliated with the center include:

- A campus and regional effort to develop alternative transportation systems. On campus, this effort has led to a course on active transportation, several design projects around electrically powered bicycles, and the remodeling of the campus for new bike and foot paths. Beyond the campus boundaries, RIT has led an effort to interconnect Rochester's numerous bike paths with multi-use trails that could extend from Lake Ontario to northern Pennsylvania, and strengthen linkages between the city and the region's universities.
- A program to promote humanitarian free and open source software development projects by students, faculty, and local developers. Many projects support the One Laptop per Child program, including educational game development, an initiative to create a repair center for laptops in and out of country, and application distribution servers. Other work in the open source community includes a language learning application and a Professors' Open Source Summer Experience (POSSE), a week-long workshop followed by a

regional one-day conference. Student opportunities created by this program include co-ops for internal and external clients of open source software development.

- A meeting place of internal, external, and community innovation interest groups such as Make Club, a textiles and wearable computers group, a local Python user's group, a student aviation and pilots club, etc.
- A home for the RIT Innovation Hall of Fame.

This past summer's program expanded on the nineteen-year precedent established by RIT's College of Science and its "Undergraduate Research Symposium." The Center for Student Innovation created a cross-institute summer undergraduate research program culminating in an "Undergraduate Research and Innovation Symposium." As part of this effort, the Center for Student Innovation provided stipends to twenty student innovators and teams whose proposed projects often had multidisciplinary aspects beyond the scope of their home colleges. These and other summer undergraduate scholars were also supported by additional internal and external programs, including the university's colleges, the Louis Stokes Alliance for Minority Participation, the McNair Scholars program for underrepresented populations, the National Technical Institute for the Deaf, and by donations from alumni. In conjunction with these programs, RIT also provided fellows with housing in the dorms.

Unlike other summer research or summer job programs where students work on projects defined by others, the CSI's program is student-driven. To apply, students wrote project proposals and recruited a faculty mentor. With the mentor's endorsement, the proposal went to committees in the colleges or the sponsoring university program or institution (such as LSAMP or the CSI), which then approved as many worthy in-scope projects as possible within their respective budgets. Fifty candidates remained for review by the CSI, and twenty were ultimately funded.

Faculty mentors generally volunteered their time, and their level of support for students' work was left to their (and the students') discretion. This paper's faculty authors received support for mentoring multiple projects and helping to administer the CSI's summer program and activities for all summer research fellows university-wide. Other faculty supported themselves or their student researchers as part of grant funding for external projects.

During the eleven-week program, the CSI fellows were required, and approximately 150 other fellows were invited, to meet weekly in the center for luncheon sessions with external presenters and to present pre-conference "work-in-progress" reports to peers. The center served as a home base for CSI fellows and as walk-in source of research support or counsel for other fellows as well. The CSI also served as an "open shop" for other students and alumni, including a group of industrial design students who eventually formed a business to provide consulting services to a company that visited the center seeking "new ideas." In short, this summer the CSI became a center of, as well as for, student innovation.

The culminating event of the summer program was the Undergraduate Research and Innovation Symposium on August 13, 2010. The event was scheduled in much the same manner as a professional scientific conference. A total of 165 undergraduates contributed to over 100 conference presentations and 50 posters. Most students were part of a single presentation, but 22 contributed to two or more. The event was scheduled with five concurrent sessions over five time blocks, punctuated by breaks and a keynote address by Jennifer Indovina, a recent RIT graduate, innovator, and entrepreneur.

In our opinion, and that of the judges (qualified alumni and external interested professionals from relevant disciplines), the work and the presentations at the symposium were of high professional quality.

The analysis that follows is a quantification of the demographics and content of the summer program, based upon registration data for the participants and a follow-up survey.

Initial Analysis of the Overall Program

Participation across colleges and other programs

Our 165 participants represented 2.2% of all eligible students (fall 2010 sophomores, juniors, and seniors). This participation rate actually underestimates the symposium's penetration, because over half of all RIT students participate in cooperative education employment as a requirement for graduation, and summer is the quarter with the greatest number of co-op registrations.

The summer program engaged students from all of RIT's eight colleges, although some colleges were better represented than others. The College of Science (COS) fielded the most participants, which was not surprising since this represented an extension and generalization of the College of Science's nineteen-year tradition of faculty and undergraduate research.

A second tier of participation came from three colleges with a large number of research-oriented faculty and students, some of whom were already participating in NSF and other grant-funded research projects. These were the B. Thomas Golisano College of Computing and Information Sciences (GCCIS), the College of Applied Science and Technology (CAST), and the Kate Gleason College of Engineering (KGCOE).

The Institute's remaining colleges, the College of Liberal Arts (COLA), the College of Imaging Arts and Sciences (CIAS), the National Technical Institute of the Deaf (NTID), and the Saunders College of Business, had relatively lower participation numbers. Though small in number, liberal arts majors participated at the second highest percentage based on their college enrollment, reflecting the absence of a co-op requirement for liberal arts majors.

College size and culture thus contributed to patterns of participation; other programs that cut across the colleges influenced participation as well. Over 20% of all fellowship students came from programs designed to support underrepresented populations (Louis Stokes Alliance for Minority Participation (LSAMP) and the McNair Scholars program). It should be noted that the CSI's award criteria favored projects that crossed college and disciplinary lines and fellows selected for CSI funding were generally in multidisciplinary projects.

Figure 1. Student Participation

	Number of Students	Percentage of Students in that College	Percentage in the Symposium
COS-College of Science	74	6.3%	45%
KCGOE-College of Engineering	27	1.4%	16%
CAST-College of Applied Science and Technology	18	0.8%	11%
GCCIS-College of Computing and Information Sciences	14	0.6%	8%
CLA-College of Liberal Arts	9	1.6%	5%
LSAMP-Louis Stokes Alliance for Minority Participation	7		4%
CIAS-College of Imaging Arts and Sciences	6	0.3%	4%
SCOB-College of Business	4	0.5%	2%
Other	4		2%
NTID-National Technical Institute for the Deaf	2	0.2%	1%
Total	165		

Notes: percentages of participants total 98% due to rounding.

LSAMP students are not included in home college totals.

NTID students also registered in one of the other colleges are NOT counted in NTID total

Percentages of students in a college are based on total college enrollment (unadjusted).

Participation by year

Participation was essentially evenly distributed across sophomores through seniors. Note, however, that because coop requirements ensure that over half of RIT students graduate in five rather than four years, fourth *and* fifth year students were counted as "seniors."

Participation across disciplines

Forty percent of CSI and all other summer fellows responded to a fall follow-up survey. Asked to identify primary, secondary, and tertiary disciplines in their projects, approximately 50% of respondents identified a secondary discipline, with a smaller percentage indicating a third discipline.

Participants' perspective of the fellowship program

The follow-up survey also asked fellows if they would participate in a program of this kind again. Sixty-two percent of respondents responded affirmatively about a summer program, and 48% for a program during the academic year. Fifteen percent said they would consider either opportunity. A few of the negative responders commented that they would participate again if they weren't graduating. Even though mentors were generally unpaid, and determined their own levels of participation with the students, 92% of the respondents indicated that they received adequate mentoring support.

Participation in the weekly lunches

Our weekly fellows luncheons were attended by approximately 80 students per week. Our respondents generally found them valuable, with 62% scoring them 3 or above on a 5-point scale.

Sample Student Project Descriptions

The above statistics document a rather well-received program with substantial impact on campus. However, the real character of our summer program is better-captured by descriptions of exemplary projects.

Wheelchair redesign

Two Mechanical Engineering Technology (MET) students from the College of Applied Science and Technology collaborated on research, design, prototype, and initial fabrication of a novel, ergonomic 4-wheel drive, electrically-powered wheelchair. One team member has cerebral palsy, and his experience informed the design process. Working with doctors and occupational therapists at Rochester General Hospital, a new "seat" design was developed to prevent spasm-stimulating pressure caused by existing chairs. The 4-wheel drive system has opened a new range of operating and maneuvering options which will also require (and enable) new control algorithms and systems. While both members of this team came from the MET program, the project required collaboration and learning outside their own domain. Several aspects of their design are under consideration for intellectual property protection (RIT undergraduates retain intellectual property rights resulting from their work).

Green social networking

A team of students from the Golisano College of Computing and Information Sciences (GCCIS) and the Saunders College of Business worked with an alternative energy company to develop an open source social website system for owners of "green energy" homes to share performance information and recruit new users. The website features intuitive user interfaces, innovative energy performance metrics and visualizations, and privacy protections. The website and the client benefited from the marketing acumen of the business student, the development capabilities of the computing students, and the environmental perspectives of both. The result was a robust package that is currently the basis of a New York State Energy Development Authority grant proposal to provide a green social networking service throughout New York State.

Best practices in science education games paper and designs

Another team researched best practices in educational video games with an eye toward increasing their educational efficacy. The group reviewed early educational game releases and explored next-generation releases currently being developed. The team also produced early-stage educational game prototypes based on their identified best practices.

Pygame game engine development for the One Laptop per Child XO

This student team developed a freely distributable, open source "game engine" to facilitate game development for the OLPC XO laptop. The game engine allows developers to write cleaner, well organized code that runs more efficiently on the memory-constrained XO. The project grew out of experiences from a prior course that resulted in incomplete or complex programs that were frequently abandoned rather than fully developed for distribution. The new game engine both restricts the developer to more organized, efficient code, and facilitates game development in the OPLC XO environment.

3D visualizations of proteins

In this project, a bioinformatics student and a statistician developed an algorithm to accurately and quickly generate 3D visualizations of proteins in order to facilitate determination of function in similarly-shaped proteins. In contrast to prior methods, their method has a lower computational load, resulting in faster image development and improved accuracy.

The team intends to continue to develop the software and algorithm, possibly incorporating rapid prototyping tools to make physical models of the proteins.

Container housing

In this unique summer fellowship project, the student researched existing disaster relief housing and developed a series of solutions that combine modular construction of interiors with the ubiquitous shipping container. The solutions developed would meet FEMA requirements and be rapidly constructed, delivered, and easily stockpiled. The student is pursuing a patent on the manufacturing approach he developed for the interior modules, and is continuing the project through prototype fabrication, using grant and investment funding. This student is already a successful entrepreneur with a company housed in RIT's Venture Creations incubator.

Conclusions

When we asked students to assess their experiences over the summer, the most common observation was that they had been empowered to pursue their own intellectual interests. Collaboration across disciplines and with other students and faculty were frequently identified as positive experiences. Universally, the students were grateful for the opportunity to be in charge of their own scholarly investigations. Several commented on their initial difficulties with group dynamics and pride when their teams eventually succeeded.

Creating environments and opportunities for undergraduate students to become boundary-crossing scholars benefits the university no less than its students. Engaged students are better students, and their enthusiasm and ability to cross disciplinary boundaries energizes and informs faculty scholarship.

The summer fellows program and the Undergraduate Research and Innovation Symposium helped advance RIT's strategic goal to enable every RIT student to have a research, innovation, or creative opportunity. It has also spawned additional smaller symposia for both undergraduate and graduate students at the conclusion of fall and winter quarters.

For each fellow, RIT invested approximately \$5,000 in stipend and housing. The dividends included papers and presentations at the Undergraduate Research and Innovation Symposium, a substantial number of ongoing student-driven projects, and the advancement of numerous student researchers, innovators, and entrepreneurs who are likely to benefit the university and society in the future. The summer fellows program was extracurricular, but it enriched and augmented the students' curricular program by inspiring independent scholarship, motivating deep learning, validating coursework, and providing constructive evaluations from symposium judges. These dividends support university and college educational objectives, as well as RIT's drive to become an "innovation university."

The Center for Student Innovation is now attempting to expand and develop the program we pioneered this summer. We hope to expand and improve the fellowship and symposium projects, build greater participation among colleges and programs, and secure internal and external resources for more participants. We are mounting additional symposia for other quarters of the academic calendar. And we are developing project-oriented courses and minors that may increase "curricular push" and "student pull" for interdisciplinary research and innovation.