Tapping the Potential of All
Undergraduate Research at Community Colleges

Edited by:
Nancy H. Hensel
Brent D. Cejda
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and
Brent D. Cejda

The Council on Undergraduate Research
Tapping the Potential of All: Undergraduate Research at Community Colleges

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Photo 1: Santiago Vallejo-Gutierrez and Kyle Flaherty of McLennan Community College at the Mars Desert Research Station. (Photo credit: Brad Turner)

Photo 2: Matt Forrester (L) assists wildlife technician Ron Newell with a chemically immobilized black bear. (Photo credit: John J. Van Niel)

Photo 3 and 4: Ocean Research College Academy (ORCA) students on a state of Possession Sound research cruise. (Photo credit: Ardi Kveven)

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Undergraduate research has proven to be a particularly effective method for developing students’ problem-solving skills and work habits, improving student retention, connecting classroom experiences to the world of work, and motivating students to continue their studies. It has become an integral part of the undergraduate experience in nearly every four-year college in the United States, but only recently have community colleges begun to engage students in research.

Community colleges play a critical role in higher education, teacher preparation, private-sector employment, workforce education, and societal development. Approximately 50 percent of U.S. jobs require more than a high-school education, and community colleges now train more than two-thirds of mid-skilled workers. In 2012, community colleges enrolled nearly eight million students in credit-bearing classes or 45 percent of all U.S. undergraduates (AACC 2014).

Four-year colleges have come to rely heavily on community colleges for their student recruitment. Approximately 50 percent of all baccalaureate-degree recipients have earned at least some credit at a community college. Nearly 40 percent of elementary and secondary teachers begin their postsecondary education at a community college, and 44 percent of recent science and engineering graduates have attended a community college. Research experience provides students and future teachers with exposure to the norms of research prior to transferring to four-year institutions and enables transfer students to adjust more readily to baccalaureate institutions (AACC 2011).

Community colleges have earned growing recognition for their contribution to workforce development and the economy. Approximately 95 percent of businesses and organizations that employ individuals who attended a two-year college recommend a community college education. Indeed, a recent review of 20 studies affirmed strong positive earnings’ gains from community college attendance (Belfield and Bailey 2012). In a 2008
report, the Government Accountability Office concluded that community colleges play a key role in a knowledge-based economy (AACC 2008).

In addition, studies have shown that community colleges play a major role in societal development by admitting students from underserved ethnic and low-income groups, providing them with credentialing, and helping them gain immediate entry into the work force. Undergraduate research can also assist all students with developing problem-solving skills, a strong work ethic, and the capacity to assume more responsibility and initiative in their work. These skills are essential to help meet the demand for a highly skilled workforce in industries focusing on innovation and product development in a competitive global environment.

For all of these reasons, it is important that community college students gain the benefits of engaging in undergraduate research. With support from the National Science Foundation, several years ago the Council on Undergraduate Research (CUR) and the National Council of Instructional Administrators (NCIA) formed a partnership to investigate the role of undergraduate research at community colleges. We received a National Science Foundation planning grant that funded six regional conversations designed to discover the existence and prevalence of undergraduate research at community colleges. When we began the project, many in higher education thought it was not possible for community colleges to provide undergraduate research experiences for their students because faculty had high teaching loads, students often worked full-time and had family responsibilities, and campuses did not have adequate laboratory space. An additional challenge was the view that community colleges were teaching institutions designed to prepare students for careers and that research was not part of their mission. Prior to receiving our grant, we had learned that students transferring from a community college to a four-year college often took a year or more longer to graduate because they lacked research experience. What we discovered during the conversations was that despite these challenges, a core group of community college faculty were developing vibrant undergraduate research programs.

Many of the community college faculty who attended the regional conversations indicated that they had participated in research during their own undergraduate years. These individuals valued and understood the power of engaging students in authentic, hands-on research as a teaching strategy and were determined to provide similar experiences for their students. We also found that community colleges had varying definitions of undergraduate research, ranging from developing students’ research skills, to undertaking applied research, to making new discoveries through basic research. Within these varying definitions, however, was the common view of community college faculty that research was a “curricular enhancement” or “value added” component of the curriculum, rather than research being
an integral component of the approved curriculum (Cejda and Hensel, 3). Research activities are often not labeled as “research” but may be experiential or service projects. Faculty who do engage students in undergraduate research often work alone in their departments, sometimes with no financial support and little administrative support. We also found several different approaches to undergraduate research, with some faculty wanting to offer the experience on the community college campus, while others were sending their students to four-year colleges for summer research, and a few were working in collaboration with industry.

At the conclusion of our initial NSF grant, we felt that if community colleges were to fully develop undergraduate research programs, they would need to consider the impact on their traditional mission. They would also need to answer the question of how undergraduate research could further the mission of the college without incurring unsustainable costs. Thus we obtained a second National Science Foundation grant, through the agency’s Course, Curriculum, and Laboratory Improvement Program, designed to assist community colleges in developing sustainable undergraduate research programs. Our goal was to help faculty find ways of integrating undergraduate research into the educational experiences of community college students. We also encouraged faculty to think about a developmental sequence of research skills and then determine the skills that could most easily be developed within the first two years of the students’ education. The chapters in this monograph set out examples of the various approaches to undergraduate research among the 100 community colleges that participated in our project and illustrate the possible benefits for students, faculty, the institution, and U.S. competitiveness.

We have divided the contributions into six sections:

- Developing and Implementing Undergraduate Research—examples to assist in designing and carrying out undergraduate research initiatives.
- Examples of Undergraduate Research—illustrations of undergraduate research incorporated into specific courses.
- Interdisciplinary Approaches in Undergraduate Research—examples of undergraduate research that involve students or faculty from multiple disciplines or that incorporate multiple disciplines in the research project.
- Responding to Community Needs Through Undergraduate Research—examples of undergraduate research that meets needs in the broader community the campus serves.
- Disseminating Undergraduate Research—examples of how community colleges and their students have shared the results of their research initiatives.
Models of Undergraduate Research—examples of developed, institutionalized models for implementing undergraduate research.

We extend our sincere appreciation to our contributing authors. It is our hope that readers will be able to use the authors’ experiences and insights to continue efforts to employ undergraduate research to enhance the quality of community college students’ educational preparation.

Brent D. Cejda and Nancy H. Hensel were co-principal investigators on this project when Brent Cejda was executive director of the National Council of Instructional Administrators and Nancy Hensel was executive officer of the Council on Undergraduate Research. We appreciate the opportunity to complete the project after we moved to new positions.

References


Introduction

The City University of New York (CUNY) is the largest urban public university system in the United States. Its 24 institutions include 11 senior colleges and seven community colleges, an honors college, and several graduate and professional schools. Of the nearly 240,000 undergraduates enrolled at CUNY in the fall of 2012, 40 percent (96,500) were attending one of the seven community colleges. The range in the number of students enrolled in each of these community colleges is also quite large (see Table 1), with fewer than 300 students at the new Guttman Community College and more than 24,000 at the Borough of Manhattan Community College. Given the diversity of New York City, it is not surprising that CUNY is also a very ethnically diverse institution, with nearly 53 percent of students of African American or Hispanic origin across all institutions. The percentages are even higher at the seven community colleges, where more than 66 percent of students are African American or Hispanic.

In this chapter, we aim to provide an overview of undergraduate research initiatives at the CUNY community colleges. The importance of undergraduate research as a pedagogical tool is becoming increasingly recognized, and there is strong evidence to support the claim that this high-impact practice increases students’ success in STEM (science, technology, engineering, and mathematics) disciplines (Graham, Frederick, Byars-Winston, Hunter, and Handelsman 2013; Hunter, Laursen, and Seymour 2006; Russell, Hancock, and McCullough 2007; Seymour, Hunter, Laursen, and DeAntoni 2004). However, the mission of community colleges historically has differed from that of their four-year counterparts—with a greater
emphasis placed on teaching. This situation is, to a certain extent, a function of the need to prepare students for transfer to four-year colleges and also a function of the very large number of students enrolled in developmental-education courses, which is part of a nationwide trend (Bailey 2009).

Nevertheless, CUNY community college faculty are part of a single academic community in which scholarly and creative activities can include research as one of the requirements for tenure and promotion. In light of this, CUNY community colleges are an excellent testing ground for faculty and administrators interested in developing models for engaging students in research as part of students’ preparation for transferring to a senior college.

**Role of Institutional Planning in Promoting Undergraduate Research**

Two main factors drive undergraduate research initiatives at CUNY community colleges: 1) the faculty themselves, acting on their own initiative, and 2) efforts on the part of the administration to institutionalize undergraduate research. Institutionalization is reflected in the degree to which each college incorporates research as an overarching pursuit in its annual Performance Management Plan (PMP). The PMP establishes the performance targets for all the colleges and schools in the university. These PMP reports, in tandem with the more narrative, institution-specific strategic plans that some colleges produce, can provide a useful window into tracking the institutionalization of a system-wide aim, such as the promotion of undergraduate research.

Some CUNY community colleges are explicit about incorporating student research into their PMP, such as the Borough of Manhattan Community College (BMCC), whose PMP report sets the objectives of “promoting student mentored research across the disciplines,” and “purchasing new equipment for academic departments and supporting faculty

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*Enrollment includes full-time and part-time students in the fall of 2012.*
and student research.” BMCC’s 2008-2013 strategic plan, *A Bridge to the Future*, asserts that faculty “research and great teaching are integral to the success of our students and not mutually exclusive,” and says BMCC’s continued success depends on its “ability to create opportunities for research and foster ongoing professional development for its faculty, staff and students.”

Similarly, Kingsborough Community College (KCC) states that “particular emphasis will be placed on preparing faculty for grant writing and administration that focuses on scholarly research and mentoring students in the research process.”

KCC has also issued a separate strategic-priorities statement for 2012-2016, and one of the priorities listed is increasing student-learning opportunities in research, among other areas, and expanding opportunities for faculty mentoring and for faculty-student research undertakings.

In its 2011-2012 Year-end Performance Report, LaGuardia Community College (LGCC) celebrated its success in increasing the number of faculty and students conducting research in its newly constructed research labs. The Department of Natural Sciences at LGCC, which houses a new research lab, hosts its own webpage promoting undergraduate research. This webpage states, “LaGuardia attaches great importance to Undergraduate Research, and opportunities for such research activities are regularly available in the Department. ... Undergraduate research is a key element of science education in the modern world, and it is a valuable asset for students to progress in their academic and/or professional careers.”

The new Guttman Community College, which welcomed its second entering class in fall 2013, represents a groundbreaking model of community college education and, as such, it is difficult to compare its programming to the more-established community colleges in the CUNY system. Guttman’s primary aim is “to serve as a laboratory for research-based innovation in community college education,” including providing “experiential learning opportunities” for its students and making “use of the city as an extension of the classroom.”

These examples serve to illustrate that student research is part of the institutional culture, but its implementation as a strategy is dependent on dedicated faculty with the skills to obtain external support, as described below.

**Individual Faculty Efforts Drive Participation in Undergraduate Research**

The teaching load for faculty at CUNY community colleges is a contract-based 27 contact hours, which translates into 13.5 contact hours per week per semester. New untenured faculty are eligible for 24 contact hours of reassigned time (spread over their first five years) in order to engage in scholarly and creative activities. The resources made available to community college
An Overview of Undergraduate Research in the CUNY Community College System

Faculty include teaching labs or other shared space, and many research-active faculty members engage undergraduates in research projects. For faculty who promote undergraduate research, these conditions present an opportunity for broadening participation and developing creative ways to introduce authentic research initiatives into the curriculum.

University resources allocated to community colleges for research initiatives include grants administered by the faculty union, the Professional Staff Congress (PSC). PSC grants are awarded annually and range from $3,500 to $12,000. These awards support all academically relevant research in the natural sciences, social sciences, and humanities. In addition, the Office of the Vice Chancellor for Research administers an annual internal grant competition, which provides $15,000 grants to support collaborative research projects among two or more community college faculty members.

CUNY community colleges expect their faculty to engage in scholarly activity to qualify for promotion and tenure, which gives junior professors, in particular, an additional incentive to pursue creative avenues for engaging in meaningful research. Faculty across the community colleges engage their students in research projects that are supported by grants from federal agencies such as the National Institutes of Health (NIH) and the National Science Foundation (NSF). Both agencies acknowledge the importance of research at community colleges for enhancing students’ success (Patton, 2011). Faculty at CUNY community colleges have received several large institutional grants, including from the NIH Bridges to Baccalaureate Program, the NSF Science Technology Enhancement Program (STEP), and the NSF Research Experience for Undergraduates (REU) grants. Other faculty members have been successful in obtaining funding for individual research projects from NSF. The following describes some of these grants and how they were structured for CUNY’s community colleges.

Professor Patricia Schneider at Queensborough Community College (QCC) has been teaching biology and administering student research projects since 1995. In 2002, she received an award from the NIH Bridges to the Baccalaureate program, which is designed specifically to encourage community college students, especially those from underrepresented minority groups, to enter research careers in the biomedical sciences. Schneider’s continuing record of success as principal investigator has led to several grant renewals. The central function of the NIH program is the placement of QCC students in research labs both at QCC and at CUNY senior colleges. Since most transferring CUNY community college students go on to a four-year CUNY college, the Bridges program is an excellent way for the students to develop relationships with labs that will provide them with ongoing support after transfer. The program is comprehensive and develops students’ skills in scientific communication by requiring them to
write reports and attend professional conferences. The mentoring program is well established and provides continuity by employing graduate students who benefitted from the program themselves as undergraduates.

It is striking that more than 80 percent of the QCC students who were part of the Bridges program graduated and transferred to a senior college. By contrast, the baccalaureate graduation rate of these students is modest, at 39 percent (P. Schneider, personal communication, June 18, 2013). This outcome suggests that the Bridges programming is successful in lighting the research spark in these students, but that more support may be needed to retain them in the four-year college environments—despite their having had the opportunity to develop ties with members of the research community.

Bridges to Baccalaureate grants have also been awarded to other community colleges in collaboration with CUNY four-year colleges: LGCC partners with The City College of New York and Hunter College, and KCC partners with Medgar Evers College. The Medgar Evers/KCC partnership offers research internships primarily during the summer months. Students are encouraged to present their work at conferences such as the NIH’s Annual Biomedical Research Conference for Minority Students. The NIH has funded the Medgar Evers/KCC Bridge Program since 2000, and it trains 20 students per year. The success of participants is demonstrated by their recruitment by colleges outside of the CUNY system, from which many obtain scholarships.

The National Science Foundation’s Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP) is similar to the NIH Bridges program in that it provides institutional grants. The focus of such grants is broad, but they are often used to promote research by undergraduates as a high-impact educational practice (note: at the time of writing, this program has been discontinued by the NSF). QCC obtained a STEP grant that was used to train students in chemistry and biology. Student mentees were paid as research assistants and encouraged to attend conferences and publish the results of their studies in the scientific literature. As with the Bridges grant, the QCC STEP program’s participants have an extremely high rate of transfer to senior colleges. QCC was also unique in being the first recipient of an NSF Research Experience for Undergraduates grant to be conducted on a community college campus. This grant, with a focus on physics, trained more than 180 students after its initiation in 2007.

Another institutional grant that has enabled significant numbers of community college students to participate in authentic research is the Collegiate Science and Technology Entry Program (CSTEP), which has been funded by the New York State Education Department since 1986. The program is designed to increase the number of students from historically underrepresented and economically disadvantaged backgrounds who
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enroll in and complete undergraduate degrees in STEM disciplines. More than 50 colleges in New York State participate in the program, including all of CUNY’s community colleges. Many CSTEP programs, for example the one at Kingsborough Community College, are geared toward students’ attaining licensure in targeted professions, particularly in health-related fields. CUNY students who are accepted into CSTEP grant projects often engage in undergraduate research with a faculty mentor and also have access to many other forms of academic, financial, and career-related support.

The Role of the Grants Officer

All the programs discussed above have a common feature—they originated with dedicated individual faculty members who persevered in seeking and obtaining funding for programs that would benefit their students. This is a fairly common approach in four-year colleges where the pursuit of external funding is just that: an exercise largely driven by faculty seeking to fund their own research and, by extension, student scholarship. Given the pivotal importance of grant funding to advancing community college students’ research, administrators in the sponsored-programs or grants office at community colleges have an important role to play.

Grants officers at community colleges that have achieved success in institutionalizing research often function as both a coach and an advocate. Such officers find themselves providing ongoing professional-development services to faculty by coaching them through the processes of looking for appropriate grant programs and then writing grant applications. They also sometimes find themselves advocating on behalf of faculty—conveying faculty concerns and research requests to senior administration. Thus these officers can also play a major role in program development. This very instrumental dual role can position the grants officer as a central figure in the research life of a community college.

At the Borough of Manhattan Community College, research is part of the college’s overall strategic plan, and it has recently hired a director of research development to coordinate and facilitate research activities. Further, BMCC supports the idea that faculty scholarship is integral to effective student-research programs, which in turn requires that resources be expended on promoting research activity and faculty mentoring. BMCC secured funding to renovate dedicated research space, and administrators spearheaded a program to coach faculty in preparing grant proposals. The program, the Presidential Scholars Program, creates a structured mentored environment for faculty to guide them through the grant-writing process.

There is a strong parallel emphasis at BMCC on student research, especially in the STEM disciplines. By their third semester, students can elect to enroll in a research-methods course that utilizes the format of small-group applied research. The course is a prelude to students participating in
faculty-mentored research projects that take advantage of the newly renovated space. The end result is a highly structured research environment that promotes student success.

Despite the success of the programs we have described that support student research at CUNY community colleges, the number of students who can be reached is still relatively small, and largely restricted to already high-achieving students. Broadening participation in undergraduate research will require developing more creative approaches to integrating research into the curriculum. Initiatives that employ genomics education and literature-based approaches are planned, but these programs are just beginning. The Council on Undergraduate Research held a workshop for CUNY community college faculty in the spring of 2012 to specifically address the challenge of integrating research into the curriculum. The workshop was well attended and the participants enthusiastic. But it takes time to create a paradigm that is sustainable and with sufficient assessment procedures in place to measure related student outcomes.

Summary

CUNY community colleges occupy a unique niche because they are part of a larger geographically focused university system in which all faculty members are governed by a single set of standards for professional development. Research is clearly a part of the wider institutional culture, and dedicated faculty members who obtained support from state and federal funding agencies have conducted successful student-research programs. Close partnerships between community colleges and their four-year counterparts can contribute to positive student outcomes and to the subsequent transfer of students. The main roadblock to broadening participation is the small number of students who can be supported by internal and external grant programs; further efforts to integrate research into the curriculum will be required to overcome this problem.

Acknowledgements

The authors thank Gillian Small, CUNY’s vice chancellor for research, and John Montanez, dean of grants at BMCC, for comments on the manuscript.

References


A Contract Can Help Make Undergraduate Research Successful

Richard S. Groover

Good communication is always essential in student-teacher research relationships, and failure to communicate effectively can result in a project’s failure. Verbal conversations obviously help, but sometimes they do not insure everyone is on the same page. The message voiced by one party is not always clearly understood by another, and inadequate listening skills can interfere. If a problem pops up by the end of the project, and all parties have not agreed with the original goal of the project, complications can occur.

Every independent student research project needs guidance from a faculty member. A written document regarding the project will help insure that all parties are clearly informed and understand, and agree-on expectations; it provides an important paper trail as to the work that was agreed upon. Such an instrument, which may have the effect of a legally binding contract, signed by students and the professor mentoring the undergraduate researcher is a wise part of planning for research activities. Building an effective written agreement may take a little time, but it will pay off later as problems are avoided and student success is improved.

This written agreement is also helpful because it can provide a structure for students to follow in conducting an independent study since, ideally, it sets out clearly defined directions, requirements, and the objectives to be met. Sometimes called a memorandum of agreement (MOA), a standard prototype format has been developed by this author, that can be edited to incorporate specific information (See Addendum 1). The memorandum defines what the student should expect from the faculty member and what the supervising faculty mentor should expect from the student. The prototype also includes recommendations regarding how faculty should evaluate the student’s project, and it covers student conduct off-campus, if the research
will include that. It also covers liability on the part of the student as well as the laws the student must follow.

In developing the student-faculty memorandum of agreement, consider answering the following questions:

1. What are the research goals for the student and for the mentor?
2. What is the expected timeframe for completion?
3. Is a final report or data summary due? If so, by what date?
4. What external rules or requirements may affect the conduct of the research (e.g., site safety, site approvals, collecting permits)?
5. If there is a third party involved (e.g., to approve access to a site), what approvals are needed?
6. What communications between mentor and student are needed during the project and how frequently?
7. If course credit is to be given, what grading rubric or other type of assessment will be used?
8. Is credit likely to be accepted for transfer for the project by a four-year institution to which a community college student might transfer?
9. Are there multiple cross-curriculum goals that could be considered (e.g., English composition, statistical analysis, mathematics, and science)?
10. If a research publication results, in what order will the authors be identified?

Although frequently no similar type of written agreement is used with graduate-level research, doing research with graduate students is not the same as with undergraduates, principally because of the differing levels of student motivation. A graduate student should know that he or she must do all that is asked and must be careful not to miss anything. Indeed, award of the graduate degree may be contingent upon the student’s doing everything that the faculty advisor, mentor, or committee requires. An undergraduate may have less personal investment and may be less inclined to do what is asked. After all, if the research project bombs, the undergraduate can always “bail” and take another class to obtain the required credits. Undergraduates are less experienced, may be less intuitive, and may need more hand-holding. Thus the memorandum of agreement helps provide the added structure needed for undergraduate projects.

Once this document is completed, the mentor or advisor should not simply have the student sign the document. A better communication strategy is for both parties to schedule a short meeting to review the memorandum in detail before they sign it. This will insure that the student understands the points made in the document and agrees to them before signing.
The basic structure of the suggested memorandum contains first, an outline of expectations regarding academic outcomes, and second, a listing of rules and procedural expectations.

_Delineation of Expected Academic Outcomes_

The academic outcomes outlined should include the preparation of a research proposal or summary. Stipulating an extensive literature search by the student in drawing up the research proposal provides a good opportunity for the student to develop research skills and to focus the direction for the research. Submission of a proposed citation list before beginning the research is best. This will let the advisor see if adequate background work has been done. As field work or active independent research begins, the student also needs to know what the timeframe is for the work to be completed.

If the research is eligible for course credit, the student should be informed, as he or she would be in a course syllabus, about the grading scale, tests, graded assignments, due dates, and penalties for not completing graded assignments.

_Delineation of Rules and Procedures to be Followed_

Undergraduate researchers often are excited and enthusiastic as they become involved in independent or supervised research. That can lead them to “forget” rules they need to follow unless the requirements are reinforced in writing. For example, if a student is researching in the field and that location has policies or regulations about collecting material, the student needs to be informed about how to obtain the necessary permits allowing collecting and told to carry those permits in the field, especially if the student is collecting independently. The student must also be aware of rules protecting certain species, for example, and clearly understand that he or she must avoid collecting the protected species.

For research in such disciplines as psychology or sociology, rules concerning research privacy may exist, and they should be spelled out early to the student researcher. The research memorandum should articulate appropriate rules to follow in all circumstances. A statement specifying that the student must follow such rules can help the student avoid running afoul of those regulations. It may be important for the advisor to clearly communicate such regulations to the researcher, which might include an Institutional Review Board’s involvement. This knowledge will also help undergraduate researchers if they continue to do research at four-year institutions or advance to the graduate level.

Safety is often a concern in research, especially if the student is working independently and is not under the constant watchful eye of the advisor.
A student accident or damage to a site could present a legal liability for the institution. Before I take my students into rivers, I make them sit through a thirty-minute safety briefing. I also have students sign a “hold harmless” statement specifying that “the college and the advisor are held harmless for any liability resulting from the activities and events in connection with this study.” Such a statement does emphasize that the student needs to be careful and act responsibly, although it may not completely protect the college.

If an off-campus site involves a third party, sharing the memorandum of agreement with the third party is a good practice. It allows the third party to know what to expect from the student and what his or her activities will be. It might be necessary to have a paragraph regarding the third-party site in the MOA, and even to have the third party or a representative of the third party sign the agreement. A review of the agreement may allow the third party to consider things they have not thought about, such as rules to be observed on their property. An example of this is an arrangement I once had with a local county park. The park opening hours disallowed access after sunset hours. It was necessary for the researcher to get special approvals to be on the property after dark. In summary, such disclosure opens lines of communication helpful in heading off or resolving possible future problems.

Two-way communication between students and mentors is critical for successful undergraduate research. The student and the advisor may need frequent contact and mutual updates. By placing the responsibility on the student for frequent communication with the advisor about the project, perhaps according to a set schedule, the advisor should not be burdened with the need to keep a calendar of meetings. Consistent communication also is needed so that the advisor knows where the student stands regarding completion of the project.

Additional rules are included in the sample memorandum found in Addendum 1, to be used as necessary.

**Conclusion**

No faculty member wants to invest precious time in unsuccessful or problematic undergraduate research projects. An investment of a couple of hours before the student research commences should reap considerable rewards for both sides in avoiding problems during the research process. A properly drafted and executed memorandum of agreement with the undergraduate researcher can provide some guarantees that the experience will conclude successfully for all parties involved.
Addendum 1

Supervised Study < SAMPLE > Memorandum of Agreement Page 1 of 2

Research Advisor: R. S. Teacher  Student: J. B. Student

__________________________________ Community College (_____ CC)

This independent study research is designed to give the student additional knowledge in ___< the subject of interest >___, with emphasis on ___< fill this in as appropriate >_____. The student will be required to learn selected material covered in readings and lectures on ___< subject >_____, master assignments in literature search relative to this project, complete field research activities as assigned, complete a final report on his/her research by August 30, 20___, and complete all other expected outcomes. The student will work independently, with some guidance from the research advisor, and is expected to complete all assignments by the scheduled due dates.

Outline of Expected Activities by the Student:

PART 1  Complete a research proposal/summary with stated hypothesis and expected methods for this research. This is due one week after the research initiative begins on May 26, 20___. The research advisor must approve this document before the actual research begins.

PART 2  Conduct a complete literature search of published articles and books relative to the research to be undertaken. The student will submit a “Literature Cited List” to the advisor by the end of the second week after the research initiative begins.

PART 3  Field data collection in the student’s project will be conducted in a timely manner, with weekly updates provided to the advisor. All field work and data collecting will be completed by the last week in July, 20___.

PART 4  Students taking the independent study course will take two graded tests: one on June 30 and one on July 20, 20___. Content of those tests will be explained in a separate document. Together with the advisor’s evaluation of the student’s progress in the research project by July 30, these will form the basis for the student’s course grade.

PART 5  Student’s final report must be completed and submitted to the advisor by August 30, 20___. This report shall be drafted in a manner similar to published journal articles.
Rules to be Followed by the Student Researcher:

- Student agrees to abide by all state and federal laws involving collection of plant and animal species. Permission to access private property, collecting permits on government land, or any other approvals that are necessary must be adhered to.
- Student agrees to abide by all rules that may exist at field sites.
- Student may at times be working without the advisor at field locations. The student must adhere to good safety practices at all times. This includes, but is not limited to, avoidance of dangerous plants and animals, being properly dressed for field work, carrying appropriate supplies such as water, and notifying responsible persons as to the student’s locations and expected return times. Because the ________ CC faculty advisor will not always be present in the field, the student must agree to hold ______________ Community College and the advisor harmless for any liability resulting from the activities and events in connection with this study.
- Student must agree to telephone and speak (in person) to the advisor or meet with the advisor every Monday at 4 pm for an update and discussion of research progress.
- Student understands and has signed the Learning Objectives (a separate document).
- It is understood that the student will submit and make a presentation of her/his research at the May 20__, Virginia ______________ Conference. The college will pay for the student’s travel and registration expenses if the project is completed as described herein.
- If any portion of the student’s research is published or becomes a part of a published document by the advisor, the student understands and accepts that the advisor will be the principal author, but that the student will be acknowledged in an appropriate way.
- Failure to perform requested assignments, meet due dates, or maintain weekly contact with the advisor during the summer may constitute the student’s breach of this agreement, which may cause the student to be terminated from the supervised study initiative and/or affect the student’s final grade.
- The above represents all matters of understanding and agreement relative to this research project.

Student: _______________________ Advisor: _______________________

Printed name: __________________ _______________________

Date: Date:
Implementing an undergraduate research program can be daunting, especially at a two-year college (O’Loughlin-Brooks and Smith 2006). In addition to the limited resources, change—such as introducing an undergraduate research program—always inspires some trepidation. Overcoming the concerns about change and resources is particularly challenging given the limited number of models available to emulate (Groover 2010).

Our rather ambitious undergraduate research program at South Georgia State College (SGSC) began after three colleagues and I attended a CUR Workshop in 2011 at Queensborough Community College in New York focused on developing such programs at community colleges. While our efforts are just beginning, we already have made strong inroads at our institution.

South Georgia State College is a small, open-access institution, with recent enrollments hovering at around 2,000 full time students. The college is also in a state of flux, the result of a consolidation between South Georgia College (now known as the Douglas campus) and Waycross College in 2013, as well as the development of the first bachelor’s degree offering at the college. It was in the midst of these changes that the elements of the research program were introduced.

Prior to the current initiative SGSC had no real research culture. Inspired by the workshop, faculty now have a handful of courses in which research is a substantial component, a yearly symposium is held at which students and faculty present original research, a burgeoning research center exists, and an institutional review board (IRB) has begun scrutinizing proposed research. All of these components of the program are important, but here I will focus on the challenges of conducting the symposium and of introducing research into courses.
Creating a Research Symposium

Each spring semester, since 2012, the Douglas Campus hosts a symposium at which original research is presented. The presenters may be either faculty members or students working in collaboration with faculty. The symposium was originally a one-day event but it proved so popular that the 2013 event was held over two days.

The symposium was conceived as a way to introduce more advanced students to semi-independent research. By working one-on-one, or in small groups with a faculty mentor the students could better hone their research skills and critical thinking. Presenting their research in a public setting was deemed to be a factor in motivating their best efforts while at the same time serving as a sort of reward for the hard work. Students have unanimously reported the presentations are their favorite part of the research experience.

While the symposium has attracted many talented and eager students it has not been free of complications. In fall 2012, when the first symposium was announced for the following spring semester student interest was high. However, between the initial fervor and the actual day of the symposium, attrition among potential student presenters became a major issue. Some students who had shown great diligence in class simply lacked the follow through needed to prepare for this more independent setting. Although initially 11 student projects were slated to be presented, the final tally ended up at six student projects.

There was much less attrition for the second year of the symposium. One explanation for the improved follow through was that the faculty had a better grasp on how to serve as mentors. Student researchers received better advising on how to design manageable projects, and they were more informed about the research process. Also, many of the second year’s presenters had observed student presenters at the first symposium and modeled their behavior appropriately.

Introducing Research into Undergraduate Course Work

Currently at least six SGSC courses include a significant research assignment, including the disciplines of psychology, economics, and sociology. Of these, the most intensive research assignment thus far is in certain psychology classes. In those classes, the required psychology research assignment is worth 200 points, with 100 points available for the final paper and 100 for completing a series of steps in the research process. Specifically, students can earn up to 40 points for reviewing articles, 15 points for developing research questions, 25 points for designing a questionnaire, and 20 points for collecting data.

When the research assignment was first offered, in summer 2012, students could earn a maximum of one hundred points for completing a research paper. They were expected to find an appropriate number of
peer-reviewed articles (depending on the class) and use those articles as a springboard for conducting their own original research. After deciding on a topic, they were to work with the instructor on developing a fairly simple research project involving data collection and statistical analysis. Students were taught the skills necessary to conduct library searches, construct simple questionnaires, and analyze basic statistics.

It quickly became clear, however, that some students struggled with basic elements of the assignment and that assisting them was not enough. Beginning in spring 2013 the assignment was refined to allow students to earn up to 100 points for completion of steps in the research process independent of their grade on the final paper. Now rather than the instructors offering students assistance, students were assigned a clear discrete step in the research process and awarded points upon completion of that step. Then they were assigned the next step and so on.

In spring 2013 the 200-point research assignment was briefly described in the syllabus for the relevant courses, with the deadline for the final paper noted in multiple locations. A brief overview of the assignment was provided on the second day of classes. At each step in the research process detailed instructions, which included the deadline for turning in that component and a grading rubric providing detailed information about how points would be awarded were provided. Further, class time was allotted for the instructor to check students’ progress on the research assignments at various junctures throughout the semester.

Although the decision to grade steps in the research process proved to be an improvement in terms of students’ grades and apparent understanding, difficulties still existed. Students still struggled with time management and ability to utilize resources (e.g., rubrics). Simply put, a small, but troubling number of students expressed uncertainty about what was expected of them despite their having received timely instructions; some struggled to complete their statistical analysis at the last minute when resources, such as computers with SPSS, were scarce.

Solving the problem of students misunderstanding what was expected of them proved tricky. On one hand, students said they felt confused because they were “overwhelmed” with information about due dates, requirements, and such, while on the other hand students requested more detailed information at each step.

In summer 2013, based on students’ struggles with digesting information, I decided to actually increase the amount of specific information given to students at each stage of the research process, but strictly limit the type of information on any one instruction. The information on the syllabus and the first overview stayed largely the same. However, at each subsequent step in the research process, students received an increased number of very narrow instructions. First there would be a rubric describing only what was
being graded next. For example, the rubric for the article reviews simply listed precisely what needed to be done to earn points; no other information was provided. A class period or two after the introduction of the rubric class time would be set aside to work toward completion of the research task at hand. Students would break off into small groups and I would check in with each as we collaboratively struggled toward fulfilling the necessary requirement.

The same day as the small-group work, but after class, I would e-mail a sample of the type of work that would satisfy the requirement we had addressed earlier. Unlike the rubric this was not a list of specific items for inclusion, rather it was a model of the completed component. (To reduce the temptation for students to simply copy my sample, each model I provided perfectly represented the form required but was intentionally of poor quality—and students were informed of that in case they could not tell!).

The informational sheets and the rubrics were also made available through multiple means. In addition to an in-class Powerpoint describing the relevant material all materials were e-mailed—at the appropriate time—to the students. Providing students multiple methods of acquiring the instructions reduced the number of students who could claim they somehow “missed” an update on the process and thus became confused about which was the most recent instruction.

Another challenge students faced was completing their statistical analyses. Once students had completed each task from the article reviews through the collection of data, all that remained was to run their statistics and write their papers in time to meet the remaining deadline for the final paper. However, the time allowed for the writing was longer than that between each previous step in the research process, and this longer period of autonomy proved detrimental for some students. Too many students waited until the last minute to work on their analyses. The problem was made worse by the fact that students needed to have access to the SPSS computers in the research center to meet the specific requirements of the assignment and the center could not support the glut of students who showed up around the same time.

While the space limitations have not yet been resolved, and student procrastination remains an issue, I have introduced one solution that is showing some signs of ameliorating the problem. Beginning in the fall 2013 semester, deadlines for all the earlier steps of the research assignment, from article reviews to data collection were moved up. Students now have a little less time for the development of research questions, the construction of questionnaires, and the collection of data, but that should not prove disadvantageous. More class time is allotted now than in past semesters for work on these steps, so that while the overall timeframe has been reduced, the amount of work students do may have actually increased. Collectively
these actions have allowed me to increase the length of time students have for statistical analyses and crafting the final paper; rather than two and a half weeks, they now have a month.

Although some students will still procrastinate, the increased time should prove helpful. The extended time should help students who are a bit more slower-paced than their more diligent peers, but are not (unlike some) determined to use the last minute whenever it arrives. And despite shorter periods of time to complete the earlier steps in the research process, students’ grades for the fall 2013 semester are comparable to those of past semesters.

The last, and most vexing, challenge has been students’ anxiety. While there are not yet any data assessing this factor, I can attest to the fact that in many ways the least popular assignment for students in my psychology courses is the research assignment. Students send more e-mails expressing frustration and anxiety regarding research than about anything else—including exams. Further, students express more feelings of discouragement regarding the research process than about writing the actual paper. This is the most difficult challenge to overcome because—despite students’ expressions of frustration and dread, the data thus far suggest students are performing as well on research assignments as on any other.

In fact the research process is bolstering students’ grades, not harming them.

In spring 2013, for the five sections of psychology with a research assignment the mean grade for the research process was higher than the means for the final research paper in every case. In all but one class the mean for the research process was higher than the mean for the exams. In summer 2013, for the three sections of psychology with a research component, in every case the mean for the research process was higher than the means for the research paper and the mean for the exams.

So, how to solve the problem of student anxiety about conducting research?

Rather than solve this last problem, I have reframed it in my thinking. The “problem”—as it exists, is that at the beginning, students express uncertainty about their abilities; at each step they voice profound doubts that they are doing things correctly; and as they approach each new step they become convinced that they could have completed the previous step better had they only known how intimate was the link between the two steps.

That is not a problem—that is research.

I was gravely concerned initially about having a room full of students essentially saying, “What the heck am I doing?” I must confess that in addition to my concern for them, I feared that my student evaluations would no longer be stellar. I worried that trying to introduce this level of research at a two-year college might have been overly ambitious.
Upon further reflection, though, my anxiety subsided. There are still kinks to work out and continued assessment will help further refine the process, but in general the research project has been a clear plus.

That some students struggle is neither novel, nor surprising. Students sometimes struggle with elements of a course that we do not expect them to struggle with and in ways that we did not anticipate. But, most unfortunately, many students struggle in silence, hidden from the instructor's view. The research assignment, particularly as it is now employed, has exposed those areas of struggle. Being privy to so much student struggle can be initially intimidating, but ultimately it allows the faculty member an opportunity to help students work through the struggle, grow and learn.

The SGSC undergraduate research program is still in its early stages. In some ways it is really still more of an idea than a “program”, with various strands of the idea at different stages of formation. Resources, including personnel, are limited. While research is being offered in more classes than before, it is still not a common occurrence. We now have an active institutional review board (IRB), but too many in the campus community remain less than fully informed about the purpose and function of that body. The research center, the only site on campus with SPSS on computers, exists to support students, but many students do not know about the center or fully understand that it exists solely for their use. As word gets out about the research center that will exacerbate the problem of limited resources. And there still is not a culture or tradition of research at SGSC, which can only develop over time.

We are at the beginning of a journey. Those of us who travelled to New York to attend the CUR conference left inspired. We are still thinking big—or perhaps dreaming big. Having heard of some innovative programs at two-year colleges we have been motivated ever since to develop a full and integrated undergraduate research program at SGSC. While we are clearly not yet where we would like to be, we are far ahead of where we started. In just over two years we have held two successful symposia, created a small-but-growing research center, established and trained an IRB, and infused research into courses without negatively affecting students’ grades. Now we will assess, modify and continue to grow.

References

I believe that after taking two or three semesters of chemistry, students tend to have a fair understanding of the basic “nuts and bolts” of the subject. At this point they can be offered the opportunity to do some problem-solving requiring a certain amount of research or broader investigation. Doing research projects at this point has the potential to encourage students to engage in constructive hard work and to inculcate an interest for both the subject of the particular study and the overall process of scientific thinking—the latter being one of the expectations of a science education.

Further, students who are “out of the box thinkers” or “creative thinkers” many times feel stifled in the highly structured environment of “time-bound test taking.” Research projects may provide such students with an avenue to express themselves scientifically in a more creative way. This may lead to their retention in class and increase their motivation to complete the semester and subsequently the degree program.

These two realizations have inspired me to offer undergraduate research options to students. Their excitement and further improvement in grades continue to motivate me. I have tried and tested two different pedagogical methods for such projects.

**Approach I. Introducing Research in a General Chemistry Class**

My first approach was to offer an “Undergraduate Research (UGR) Assignment” option in my syllabus for General Chemistry II, the course generally taken by students after they complete the Fundamental and General Chemistry I courses. The students who were interested in choosing this option were provided with suggested topics relating to the course’s curriculum and textbook, but the topics required delving deeper into the application of chemical concepts. The students had to complete the
course’s required reading and attend lectures. Then I offered to mentor/facilitate their work on the research topic they chose, during office hours or at any other time available. The nine students participating were interested in three topics, but finally selected one by a random lottery.

The students solved the problem they were interested in by investigating various aspects of the issue and related parameters. This required visiting the library, consulting various books, doing web-based searches, and discussing issues with me as their facilitator or supervisor. They did critical thinking regarding many aspects of the problem and ultimately summarized their observations, findings, and answers to the chosen question in a paper. Students collected relevant data or information available to support their conclusions and cited this information using the American Chemical Society (ACS) reference style. The students submitted their respective papers to me for evaluation as a part of their grade.

In addition to this paper, they had the option to prepare a poster and submit it as a part of this assignment. The students were also given opportunity to present their posters at the college-wide service-learning/undergraduate research showcase. This was visited by faculty judges, other faculty, deans, and other students. The participating students got an opportunity to speak about what they had found out.

Students opting to do this Undergraduate Research project option were given guidance to facilitate their critical thinking to help them complete the assignment. They consulted me during office hours and/or other available time. I gave them the opportunity to skip the semester test on the textbook chapter on which their assignment was based. Instead of taking the structured test, they instead focused on showing their familiarity with the material by completing the assigned investigation.

**Approach II. Offering a Special Project Section**

With this option, students enrolled for three credit hours in a separate special-projects section that allowed them to do laboratory-based undergraduate research projects. Just one or two students could be enrolled per semester. The students did the work during the semester and presented it at a faculty forum. They generated original data and discussed their results. Students got so involved with their research. They ended up extending their lab experience by enrolling for consecutive semesters in the special-projects class and furthered their projects in subsequent semesters.

Whereas the first pedagogical approach was more useful for B-level students to achieve better understanding of the course material and was a powerful method for introducing students earning B- or C grades to an alternative learning method, the second approach clearly appealed to the
out-of-the box and adventurous thinkers, as well as to high achievers (usu-
ally A-students) who wanted a new learning experience.

In undertaking the pedagogical experiments, my primary hopes and 
expectations were for:

- enhanced student interest in learning chemistry,
- a benefit for “out of the box” thinkers,
- an innovative, enjoyable and worthwhile undergraduate research 
  experience for students,
- better student understanding of chemical concepts and improved 
  grades in the class, and
- better student motivation to complete the semester and, 
  subsequently, their degrees.

**General Results**

Among the nine students choosing Approach I—the research option within 
the General Chemistry II course—four of the nine typically scored B’s in 
previous coursework. Their intention was to gain more understanding of 
the subject, even though they generally had low levels of confidence and low 
self-images as students.

This approach allowed the students two to three months of the semes-
ter to study and digest the material and do the project, versus spending 75 
minutes taking a test in class on the same material. The extended time took 
the pressure off and gave participants motivation to study that boosted their 
confidence. During this time, I was available to help students understand 
the materials. Students also told me that it helped that I offered help to 
organize their research and assist them in outlining their poster.

Throughout the project, I met with students and asked detail- oriented 
questions regarding the content of their projects to help them think and 
increase their knowledge base—essentially trying to push them to A-grade 
study habits. Also, empathetic questions throughout the semester about 
how they were “feeling” gave them a chance to voice their concerns.

I found that B-students achieved better understanding of their 
already adequate subject knowledge, and they had the experience of 
learning presentation skills and thus boosting their overall confidence. 
C-students who were struggling with time constraints in their schedules 
and who had difficulties taking tests got a ray of hope through this alterna-
tive study method. They also got the experience of presenting their project 
work. And A-students who were “out of the box” thinkers got a reprieve 
from traditional test-taking to study and perform differently. They also got 
presentation experience.
Approach I. Some Specific Chemistry Projects and Results

Some students improved their performance and grades through participation in the research option. I will discuss seven of the nine. For example:

- One student reviewed the process of creating ammonia from hydrogen and nitrogen. She demonstrated very good understanding of the concept of chemical equilibrium, progressed very well in tests on information in other chapters of the textbook, and passed the semester by bettering her grade to an A.

- Another female student studied different types of chemical reactions in wastewater treatment in the local city, learning which ones cleansed the water so that it could be released back into the environment. Studying the material in the course’s textbook on chemical reactions in this manner helped deepen her understanding. She earned an A on the final exam.

- One male student who was having difficulty on chemistry tests decided to study the textbook material on chemical kinetics by investigating formation of photochemical smog. By this applied work on the kinetics, he learned where we as a society can prevent this chain of reactions and have healthier air to breathe. He also bettered his grades to an A by getting interested in the subject.

Three of the students were typically scoring C’s when they chose the research option as an alternative to taking conventional tests on particular material. They did not have clear study habits, were dependent on being spoon-fed material, and had low academic standards for themselves. Requiring them to make and present posters based on their research facilitated independent thinking and promoted a clearer focus on the content of the material they were studying and investigating. The presentation requirement forced them to actively engage in their independent study. Since the poster presentation was an alternative to test taking, the students were compelled to give their maximum efforts. They realized that they got a better understanding of the subject this way and were more motivated to learn.

The research approach definitely helped one student who was a very hard-working student who kept missing a B by a small margin. She was beginning to feel dejected and was thinking of dropping the class. When offered this research option, she took up the study of acids and bases using by real-life examples. Her focus on and interest in the subject suddenly began to grow. She not only produced a very succinct paper and poster but also hiked her grades in the later part of the semester and passed with a high B.
Two of the students who took the research option were typically scoring A's to begin with, but they wanted to obtain extra experience. They demonstrated hyper enthusiasm for the project initially, which led to haphazard study and over-confidence, which led to a lack of details and quality. Thus, as they were preparing their final presentation, I told them I expected them to outline various paragraphs, complete with subtitles, before writing their detailed paper, and I asked them to address detailed questions that required them to do extensive reading and research. Throughout the process, I was there in person and via emails to answer queries when they had any.

Ultimately, this research experience gave students a feel for independent yet logical scientific thinking and investigative skills. They also experienced a presentation experience akin to a thesis defense. One student who studied chemical compounds in saliva and tooth decay ultimately made a flawless presentation and planned to attend dental school. She earned high A's in all her chemistry classes at Mesa.

**Approach II Projects and Results.**

In Approach II, four students carried out special-section research projects. The students were already earning GPA's of 3.8 to 4.0; two aspired to get their bachelor's degrees in chemistry and the others were planning to go to engineering and medical school. With these students, I found I needed to monitor them constantly to insure that they maintained high standards in their work and achieved their maximum potential, making sure that they had the requisite equipment available and that experiments were proceeding on a logical track. Fortunately, universities and a local laboratory willingly helped out, giving their equipment and lab support for students' projects.

Before preparing their final presentation, these students were asked to write a detailed paper about their projects. They were expected to outline various paragraphs with subtitles and were asked to address detailed questions that required them to do extensive reading and research. They were also required to do a mock presentation of their project, accompanied by possible queries.

This pedagogical approach produced some interesting projects. One student did a lab-based project investigating the presence of the heavy metal cadmium in soils. Investigation included the methodology of obtaining and handling samples, the chemical process of determining cadmium levels, and a discussion of the results. This student ultimately did a graduate degree in engineering. Another student studied whether wheat grass could be used to remove cadmium from polluted soil using the process of phytoextraction, since it has a much smaller ecological impact and is cheaper than current
clean-up methods. Yet another student studied textile dye waste generated on campus. In this laboratory-based study, dye wastewater was added in differing concentrations to soil samples containing two types of plants, which were grown in a controlled greenhouse atmosphere. The results led to the conclusion that this approach could possibly provide a “green” method of dye-waste disposal that could also beautify the landscape.

**Conclusion**

I am excited that all my initial hopes and aspirations for the two different pedagogical approaches have come true for most of the students opting to participate in some kind of undergraduate research. This gives me a certain degree of confidence that research can offer students a potent avenue to express themselves scientifically in a more creative way. This may instill in them a new-found liking for the discipline and motivate them to pursue and complete the semester and the degree program.

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Lamar State College-Orange (LSC-O) has faced significant challenges in providing opportunities for student research, largely stemming from its status as a two-year, open-enrollment institution with approximately 2,400 commuter students. The majority of the student body may be classified as non-traditional, with the average age around 26 to 28. Female students outnumber male students by roughly 2.5 to one. Approximately 75 percent of the student body is Caucasian; African-American and Hispanic students make up approximately 16 percent and 6 percent of the student body, respectively. (Lamar State College—Orange 2013a).

Most of the LSC-O full-time faculty have a high teaching/administrative load compared to university faculty and thus have not regularly engaged either in academic research of their own or regularly engaged students in any research project. However, inspired by participation at a Council on Undergraduate Research workshop in Austin, Texas, in 2010, faculty have since striven to foster an increased culture of undergraduate research by forming an Undergraduate Research Committee. This consists of the dean of instruction (author Dando) and four full-time faculty members, who provided oversight for faculty-led undergraduate research projects in a program developed by author McClure and implemented for two academic years (2011-2012 and 2012-2013).

The Research Project:
Lacking a funded research program, McClure designed a “grass-roots,” very low-budget research project involving a systematic survey of the primary-burrowing crayfish species of southeast Texas (in Orange, Jefferson, and Jasper Counties). These crawfish burrow underground and typically only inhabit fields, yards, and neighborhoods. The questions to be addressed in
the study included which species occur in southeast Texas, what ecological factors affect their distribution, how urbanization affects this distribution, and how existing strategies for collecting the species for research can be improved. It was a project that students could participate in with minimal training, and it involved almost no additional travel or expense.

To solicit interested volunteers, McClure posted colored fliers briefly describing the research project at various locations of the campus, including on his office door and in several of the campus's science laboratories. Participants had to be currently enrolled at LSC-O, but there were no restrictions concerning numbers of hours enrolled or the student's major field of study. There were no deadlines, and new participants could sign up at any time during the study. The students who responded were asked to fill out an information sheet, after which they were considered part of the research team. Student researchers were loaned the traps and nets necessary to collect the crayfish and were given data sheets for compiling field notes at collection sites of their choosing. Student participants were instructed on how to deploy and retrieve the traps and how to fill out the field-data sheets.

The initial research team for the 2011-2012 academic year consisted of nine students, all of whom were seeking associate-of-science degrees in natural science. Most of the first-year team members were sophomores, but two freshmen expressed interest in remaining active on the team for the second year. The second-year team (academic 2012-2013) gained only three new student recruits, two of whom were natural-science majors and one of whom was studying to be a medical office professional.

Research Methods, Preliminary Results

The student researchers collected specimens of burrowing crayfish using both nets and traps that McClure constructed based on published designs (Norrocky 1984; Welch and Eversole 2006). Field data concerning location, time of day, weather conditions, and physical features of the collection site were gathered along with crayfish specimens. Upon successful collection of specimens in the field, student researchers brought their specimens and data sheets to the faculty researcher individually. Species identification and gender determination were done by McClure, and most of the specimens were retained and preserved in the lab.

Most of the student researchers reported much greater success collecting specimens using nets rather than traps or by hand, and the majority of specimens collected in Jefferson and Orange counties were the Old Prairie Digger Crayfish, *Fallicambarus macneesei*. *Cambarus ludovicianus*, the Painted Devil Crayfish, was collected in Orange and Jasper Counties, with some specific locations in Orange County yielding both species. Based on types of collecting locales (primarily suburban and semi-rural neighborhoods),
preliminary results suggest that the Old Prairie Digger species may be more prevalent in suburban environments than the Painted Devil Crayfish. However, the number of the latter species collected was too low to arrive at conclusive results concerning habitat.

**Student Participation**

No incentive other than being involved in a scientific research project was offered to the student volunteers, who also were told that it was difficult to predict what meaningful scientific conclusions, if any, would result from this research. They were told that depending on their level of involvement and effort, participants would be acknowledged in any publications regarding the research (as is done below) or could possibly serve as co-author of a publication in the event that a significant manuscript based on the results could be prepared for a scientific research journal.

Regular meetings (bi-semester to monthly) were held in an attempt to bring the student participants together and to discuss the course of the project. This was aimed at giving them a sense of teamwork and camaraderie, although several of the participants already knew each other prior to the project. McClure served as the repository of information gathered by each student participant, and regular updates were emailed to the entire research team, as well as discussed in the meetings.

Student participation in the first academic year was fairly successful. Eight of the nine students were successful in the collection of specimens and field data. However, attendance at the scheduled meetings was highly sporadic, apparently largely due to other demands on students’ time, and many meetings were cancelled for lack of attendance. Thus email became the primary mode of communication, which unfortunately reduced the element of camaraderie sought within the team. Active student participation in the second academic year was considerably lower, with only one student actively collecting specimens and regularly attending scheduled meetings after signing up to participate. At the end of the second academic year, McClure decided to put the project on hiatus.

**Challenges Faced, Lessons Learned**

The college faced several challenges in maintaining this undergraduate research project. Because LSC-O is a strictly commuter campus, students generally do not interact with each other outside of class activities. It was also difficult to assemble outside of class adult students with different class and work schedules and often considerable other personal demands on their time, even though the difficulties of scheduling physical meetings were partially overcome by email communications.

Although LSC-O enrolls more than 2,400 students a semester, students showing an active interest in science and/or majoring in science make
up a small minority of the student body. Most of student body consists of students majoring in allied health fields and various other technical majors; many such majors are unlikely to be interested in performing field biology research. Thus it was not surprising that all but one of the student participants were majoring in natural science, a major that attracts fewer than 2 percent of LSC-O students (Lamar State College-Orange 2013b). Opening the research project to all majors, though, allows any interested student the chance to participate, and in fact, the most active participant during the second academic year was the non-science major.

Weather was another limiting factor. Prolonged periods of dry weather occurred during the first academic year, during which crayfish were reluctant to exit their burrows, thus precluding field work for several months during the first year. The project resumed once wet weather returned.

Lack of funding to support research was another challenge. In order for a small college to achieve the benefits that students receive from participation in research, it is important to keep research projects as inexpensive as possible. This particular foray into undergraduate student research shows, though, that it is possible to conduct field research and add to student learning even when there is no financial support. With even a small level of financial support, we anticipate that further undergraduate research can take place at LSC-O. We look forward to integrating undergraduate research projects within courses, making use of the regular general educational funds.

Other challenges existed for McClure as the faculty member supervising this project. Because the project was unfunded, paid release time was not available, which limited the time he could devote to the research and scheduled meetings. As the culture of undergraduate research continues to grow among two-year institutions, funding in the form of release time and/or grants may facilitate further growth, as well as provide incentives for faculty and staff who might otherwise be reluctant to initiate research projects. LSC-O will seek to develop incentives for faculty participation in other undergraduate research projects in the future.

The undergraduate research program and the research project also did have its share of successes, however. Despite the challenges, the number of students volunteering for the project was higher than initially expected. The experience also provided significant opportunities for the students to see how scientific research and reporting can become a powerful learning tool. It also allowed the faculty member to explore how undergraduate research can enhance and add value to the classroom. Student researchers reported that the color fliers advertising the project sparked their interest in volunteering, and that they performed the research primarily because they were interested in it. They also reported that they benefited from the hands-on experience and the knowledge gained outside of class in a subject they enjoyed.
Acknowledgments

The undergraduate research team for 2011-2013 consisted of Kristin Clark, Kallie Davis, Bobby Eaves, William Hall, Jeff-Free Hoke, Courtney Jackson, Bonnie Joleen, Vanissa Low, Brandon Matson, Kristena McNeel, Stacy Mitchell, and Samantha Townsend. In addition to the two authors, the college’s Undergraduate Research Committee included Elias Jureidini, Gwen Whitehead, and Lisette Hodges. Joseph Kirkland, the LSC-O vice president of academic affairs, was also very supportive of the program, and Ira F. Greenbaum (Texas A&M University) supplied some of the raw materials needed to construct the nets to collect the burrowing crayfish.

References


Undergraduate Research in an Urban Community College’s Comparative Anatomy Class

Mary Theresa Ortiz and Loretta Brancaccio Taras

Comparative Anatomy is a four-credit course for biology majors at Kingsborough Community College (KCC) of The City University of New York, focusing on structure, classification and adaptive modification of vertebrates. Prior to 2011, the course had been taught in a traditional format with three hours of lecture and three hours of lab each week. Since 2011, the course has been offered in a writing-intensive hybrid format. That version of the class meets four hours per week, with one hour of lecture and three hours of lab. In addition, in fall 2013, this course evolved further to include a longitudinal ornithology research project. KCC, located in Brooklyn, New York, is surrounded on three sides by water - Sheepshead Bay, Jamaica Bay, and Rockaway Inlet (the Atlantic Ocean). Many avian species, such as gulls, cormorants and swans, inhabit the campus and the surrounding area.

In the past, birds have been the focus of a number of faculty mentored research summer projects. However, few science classes incorporate undergraduate research projects, and no class on the campus ever incorporated a study of these birds in which the entire class participated in the nature and process of science (Brewer and Smith 2009; Friedman 2012; Granger, et. al. 2012). For the fall 2013 class, students worked in groups to identify and catalogue birds weekly at various locations on and near the campus. Using skills learned during laboratory sessions, such as identifying external anatomical features (size, morphology, color), students gathered data on the species, numbers, and locations of birds they identified and presented their findings in a written report at the end of the semester.

Structure of the Research

Each student in the Comparative Anatomy class used skills learned in the lab and participated as part of a lab group in the ongoing research project.
aimed at identifying, cataloging, and studying the birds on and around the KCC campus. Each lab group contained three to four students, with each student in the group earning the same grade on the project. By a specified date, each lab group was required to submit a detailed lab report that made up 20 percent of the students’ final grade in the class. Students’ grades dropped by 10 percent for each week or part of a week in which the report was submitted after the deadline.

For 15 minutes one day each week, for 10 weeks, each lab group observed, identified, and catalogued the birds at one of three assigned locations on the KCC campus: the Sheepshead Bay sea wall (SB), Jamaica Bay sea wall (JB) and the Rockaway Inlet sea wall (RI). Two groups were assigned to study at each location, designated 1 and 2. Students were provided with a map and photographs of the KCC campus to help them identify each location.

All data collected were entered into an Excel spreadsheet using a template provided by the instructor. The observations made and the data each group recorded included: location of observations, date, day, time, weather conditions, tide, number of species of birds observed, and several characteristics of the birds spotted. Students also took photographs or provided drawings of each species of bird observed over the 10-week project period. Helpful websites and references were provided to help students identify the birds they observed.

In addition, students were reminded to work with a partner, dress appropriately, and carry their KCC ID card. Finally, students were reminded to respect the birds they observe, not to annoy or harm them in any way since they are guests in their habitat. They were encouraged to enjoy the beauty, gracefulness and design of these incredible vertebrates.

During laboratory discussions students were taught how to use external characteristics to help identify each avian species. Morphology, color and behavior were key characteristics for identification. For example, Laughing Gulls have an orange beak where-as Ring-billed Gulls have a dark ring on their beaks. Other features, such as wing structure, are very similar for these two birds.

The lab report each group submitted contained a title page, abstract, hypothesis, materials, methods, results, discussion, conclusion, and references. The results section contained their data in an Excel spreadsheet, a graph with the species observed on the X-axis and how many of each species observed on the Y-axis for the ten-week study period. It also included a photograph or drawing of each species observed. The discussion section contained an explanation of the students’ results, including any patterns and their implications. In addition, students were asked to include suggestions for future modifications to this research project, and their group’s opinion of this study. Students were provided with a grading rubric so they were aware of what was expected in their report.
Throughout the semester the instructor met with each group during the lab section to discuss how the project was progressing, answer questions, and provide input. Probably the biggest challenge facing the students in each group was coordinating, planning and implementing the observation periods since Kingsborough Community College is an urban commuter school. Many students not only attend classes at KCC; they often work one or two jobs and have family responsibilities. Devising a schedule so that at least two group members can conduct 15-minute observations each week for ten weeks is no small task. Another challenge is having three to four students working as a unified group to complete their part of the research project. Occasionally, compatibility issues arise, when the chemistry among students is not ideal. In those instances, the instructor can work with the group to try to address any difficulties. Inclement weather presents another challenge; because of their hectic schedules, if the weather interferes with the observation schedule, it may be impossible to re-schedule a weekly observation session.

Since Kingsborough Community College is located on the east coast of the United States, this study of marine birds incurs no cost to the college to conduct. Although many colleges do not have this type of ideal location, equally economical ornithology studies can be implemented using local environs. Parks, arboreta, or any open spaces may provide adequate sites for similar observations and studies.

Data collected during this research project is added to that of subsequent classes. In future semesters, students will examine these data to determine trends in avian populations, ecological implications, both for the campus and beyond, and develop hypotheses regarding future results. An added benefit of this project is that students observe live organisms as opposed to the preserved specimens traditionally utilized during the laboratory sessions of a traditional comparative anatomy course. Students not only learn comparative anatomy, they also experience the nature and process of science, as well as have the opportunity to work as scientists by being actively engaged in a research project to which they make a significant contribution.

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McLennan Community College (MCC) sent two crews of students and faculty advisors to the Mars Desert Research Station (MDRS) outside Hanksville, Utah, to conduct student-driven research in April 2013. This was the pilot season for a new program at MCC called “Mars 101,” which introduces students to analog research—that is, research in a simulated environment. Crew members at MDRS live as future human explorers will live on Mars: rationing water, eating dehydrated food, conducting Extra Vehicular Activities (EVAs) in spacesuits, and living in close quarters with five other people. This experience is a truly incredible opportunity for both students and faculty to expand their ideas of the possible and to develop new connections between the classroom and the real world.
MCC, which is located in Waco, Texas, began to investigate using the desert site for student research in January 2012. At that time, MCC sent five faculty members representing chemistry, engineering, geology, biology, and management to MDRS, along with a geology faculty member from Del Mar College in Corpus Christi, Texas.

During this initial simulation, the faculty members developed a curriculum to help future student crews learn some of the skills necessary to be successful field researchers, while working in simulated conditions themselves. First, an orientation EVA was developed to acquaint students with the basic skills needed to function in the simulated environment. For example, riding an All-Terrain Vehicle (ATV) in street clothes presents challenges, but those challenges increase ten-fold when riding the ATV in a space suit.

One of the first things a rider will notice is that it is impossible to rotate at the waist and neck to see something behind the ATV. Add to this the need to navigate via a hand-held GPS unit and communicate with other riders using walkie-talkies duct-taped to an arm, and the experience can quickly become overwhelming. Once the rider gets off the ATV, the situation does not improve. The explorer must then collect samples or sketch a geological feature while wearing thick gloves. Using a rock hammer becomes dangerous when the explorer strikes a rock and the recoil of the hammer hits the face shield of the explorer’s helmet. Nothing is easy on “Mars.”

In addition to the orientation EVA, formal lab work was developed in chemistry, geology, and microbiology. One feature of the curriculum developed is that all participants, regardless of specialty (faculty) or major (student), are required to participate in all fields of study. The chemistry student must learn geology, and the engineering student must try his or her hand at using a microscope. A rough schedule for the week-long simulation was set up during which students would have set activities to conduct during most days, but which also allowed students two half-days and one whole day to work on their own research. The students needed some structure to ensure adherence to the simulation, but they were also given sufficient flexibility to conduct their independent work.

Once the day’s work in the field is done, attention must be focused on keeping the hab running. The generators must be checked, ATVs repaired, plants in the greenhouse scrutinized, and dinner put on the table. Additionally, reports must be filed nightly with the Mars Society on the EVAs completed, the status of consumables, and other information.

**Crew Complement**

For safety and viability, we determined that a crew would consist of two faculty members and four students. The first faculty member would be experienced at MDRS and would be the crew commander. The second faculty member
would be a commander-in-training, new to simulation but interested in leading future crews to MDRS. The remaining four slots would be awarded to students selected through a competitive process. In their applications, students would submit plans for independent research, addressing questions such as how the research related to their career goals, issues of budget and timeline, and most importantly, why their research had to be done in an analog environment. They would need to partner with a faculty advisor for their research, one who would not travel with them to MDRS.

Upon returning from the hab to campus, the students would be required to create a research poster for the MCC Student Research Symposium and also to present a 30-minute overview of their research to other students. Since MCC would send two separate crews, this would expose a total of two new faculty and eight students to analog research every year.

The four students and commander-in-training on each team would also be required to choose a specialty at MDRS—geologist, chemist, biologist, astronomer, or executive officer. Faculty members could not serve as the executive officer. Those volunteering to serve in one of the first three roles would be required to learn the research procedures of the field work prepared during the initial season and teach it to his or her crewmates while at the hab. The astronomer would be required to complete online training and learn how to use the hab’s telescope. The executive officer would be required develop the crew patch, complete reports to the Mars Society, and perform other similar duties.

Having each student responsible for the content of the field work not only relieved the commander of having to be a Master of Everything, but also gave the other crew members a stronger sense of ownership of the entire experience. Crew members could also volunteer to serve, in addition to their regular duties, as the crew photographer, head chef, health and safety officer, lead engineer, or the greenhouse keeper.

Finally, in order to enable the students to get academic credit for their work, students would enroll in a special topics class in their field, with their advisor as instructor. A biology student, for example, would take BIOL 2389, whereas a psychology student would take PSYC 2389. This was an interesting way to approach this situation, since the four students in a single crew may all be enrolled in four different classes, but it allowed us to bring in students from any discipline into the program. Also, since the students would be getting academic credit and a grade for their work, we expected this to provide additional incentive for students to take the work seriously.

**Recruiting and Training Prior to Simulation**

We began recruiting for faculty members in May 2012, prior to the planned April 2013 crew rotations. By August of 2012, we had two experienced commanders in place and then identified two additional
commanders-in-training, representing the fields of environmental science and speech. Strong recruiting efforts were undertaken in the fall semester by the faculty involved in the initial simulation. We visited classes in scientific and health-technology fields; we stressed the hard work and long hours required for the simulation, but also focused on the sense of accomplishment and the idea that the work that the students could do at MDRS would set them apart from almost any other job applicant in the future. Although the course would not start until the spring, the deadline for student applications was October 31, 2012. All this work was headed by a Mars 101 Program Director, the author, who had experience out at MDRS but who would not be on a crew for the upcoming season.

Ultimately, four students were chosen from engineering, one from biology, one from geology, and two from medical laboratory technology (MLT). Of the eight students chosen, six were male and two were female. Four were in the first year of their respective programs and the other four were in their second year. The average student age was around 25, but the actual ages ranged from 18 to 35.

Once the crew selections were made, students submitted a non-refundable $500 deposit by November 15 to hold their slot on the crew. The remaining balance of $1,250 was due at the beginning of the spring semester. Students were encouraged to use the holiday break to begin their research, as deemed appropriate by their faculty advisor. We also tentatively planned to send at least two student researchers to the annual Mars Society Convention to present their research as a reward for high-quality work.

During the spring semester prior to travel to MDRS, both crews met as one large group for five evening meetings. These meetings were run by the Mars 101 Program Director. Each meeting was specifically designed to emphasize team-building and ensure that the students were making progress with their faculty advisor on the research they had set out in their applications. At the meetings, no distinction was made between the students and the faculty members. They were just members of the crew. Surprisingly, students had no problem transitioning from “Larry, my commander” during crew meetings to “Mr. Benton, my chemistry professor” in the classroom. We established the rule that the commander had ultimate responsibility for health and safety decisions, but stated that usually the crew would decide things together.

In the first spring meeting, after signing many legal forms, including disclosure of full medical history, crews developed “team operating agreements,” which established basic rules of conduct and the consequences for breaking those rules. They also developed their own crew patch and began to develop a sense of camaraderie.

The second meeting focused on food. In the simulation, participants often have breakfast and lunch when it is convenient for them during the
day, but dinner is eaten together. This is important for crew cohesion and is often the only time the entire crew is at the same place at the same time. Thus, each crew was given a recipe during the first meeting and was instructed to bring everything necessary to prepare that dish for the second meeting. Both recipes were intentionally complicated, time-consuming, and potentially frustrating. Crew members convened in an unfamiliar private home to use a small kitchen with limited counter space and utensils. Both crews had to prepare their meals at the same time. As phyllo dough tore and the eggplant almost burned, somehow, twelve individuals began to meld into two crews.

During the remaining formal evening meetings, the students presented their research plans and EVAs, and also practiced other necessary skills. Students completed GPS training and ATV safety training. Each crew also had to plan one additional separate meeting during which they watched The Mars Underground, a documentary on the humans-to-Mars grassroots movement.

By the end of March, all preparations for research were complete, and the crews were prepared. Three days before the first crew was to leave, however, one of its student members suffered a personal tragedy and could no longer join his crew at MDRS. At the very last minute an adjunct engineering faculty member was put on the crew. Then on April 5, 2013, MDRS Crew 128A drove to the airport to fly to Grand Junction, Colorado, where their adventure on “Mars” would begin. After spending the night in Colorado, they drove a rented suburban down to Hanksville to relieve the current crew, from Belgium, at the site. That group drove off with the rental car, leaving the first MCC crew truly alone.

**Avoiding Problems and Future Plans**

All in all, surprisingly few things went wrong. We had tried to anticipate possible problems and put plans into place to avoid them, and this planning paid off.

Our biggest concern had been to prevent the idea of this trip being an “education vacation.” We wanted students to recognize that this was not a week to “play Mars explorer.” We achieved this by continually communicating expectations, from the student-recruiting phase through the training phase, during simulation, and then even upon return. Having students in charge of their own research was also important. Since each student had his or her own independent work to do, there were no slackers. Additionally, requiring applications in October for a class that did not start until January helped to ensure that we attracted crew members who were serious and forward-thinking.

Our expenses ran light, so ultimately we were able to send all seven students, plus several faculty members, to the Mars Society Convention in
Colorado in August 2013. The students benefited from seeing people in the space-advocacy community respond to their work. The college benefited by showing that the work done at MCC can compare to work done by researchers from major U.S. and international universities.

All of the training done in advance of the actual simulation was crucial. Even activities such as cooking and watching movies served to meld six individuals into one team that was committed to the group’s success. We emphasized that we needed people who wanted to pitch in. “If you see a dirty dish, clean it. If the engine on the ATV won’t start, go to the Internet and figure out how to fix it.” Cultivating this assertive problem-solving/problem-preventing attitude ensured that our crews functioned effectively.

Insofar as the actual research done at MDRS, some of the students did exactly what they set out to do, some students changed their plans early in the semester as they dug more deeply into their topics, and a few students learned the importance of having a backup plan once they got out into simulation. The two MLT students studied fatigue and hydration, and their research went smoothly, according to their initial plans. The biology student had initially planned to do a general comparative study of major microbial taxa, and eventually settled into looking specifically at physicochemical and respiration dynamics. One engineering student who was building a radio telescope had not installed the software on the laptop he was bringing to MDRS (he had only installed it on a home computer), and found himself trying to figure out how to download large files within the bandwidth restrictions of the hab. Another engineering student who built simulation-friendly HAM radio headsets realized he had underestimated wear and tear on his equipment and had to make some adjustments in the field. These were not, in our mind, failures of the research; instead, we saw these as valuable learning opportunities for the students. Our plan is to highlight these experiences for future crews, to help them see that these kinds of setbacks in research, while never pleasant, are generally expected, and to help them develop the mindset required to bounce back quickly.

When we had to replace a crew member at the last minute, we were lucky in our choice, but we should have had a better backup plan. Our plan for the second season in 2014 is to have one faculty member tentatively plan on being at the hab for both of the one-week rotations. We would not recommend sending anyone to MDRS who had not been adequately prepared.

Requiring students to present their research upon return to MCC increased the buzz around the program, and was good experience for the researchers themselves. This year (2013-2014) we have more student interest than we did last year. Choosing some students in the first year of their academic program meant that those students are still on campus and are great recruiters.
By including a commander-in-training on MDRS crews, we have also ensured sustainability of this program. As new faculty members train to serve as crew commanders, we are less susceptible to the program failing due to burnout. We always have fresh faculty members excited about the program, and those faculty members are now coming from fields outside of science. The new commanders-in-training for the 2014 field season are from economics and nursing, and are bringing with them a larger potential pool of student researchers.

On the administrative side, we also made the decision to have an additional faculty member who had experience as a crew member at MDRS serve as the Mars 101 Program Director. This person stayed at MCC to run the program throughout the academic year. By having a separate person as administrator, faculty members who were serving on the 2013 crews were not expected to also run the spring semester meetings or worry about student recruiting or general administrivia. They could focus on building their rapport with their crews.

**Conclusion**

Many of the small decisions made in the initial development of the program ultimately led to its success. Despite a bit of snow, a dust storm, and a rainstorm the two crews managed well. Each crew member came back with eyes wide open, absolutely amazed that he or she had made it. For some, their trip to “Mars” was the first time they had ever been on an airplane or the first time they had ever left the state of Texas. In their own way, each crew member described the experience as life-changing—something he or she never thought of being involved in.

The faculty on the crews got to be there when our student crew members had that true “Aha!” moment. Getting out of the classroom, away from email, away from all the other demands on our time, we could truly focus on our students in a way we can never do on campus.

As for the students, most of them were surprised at how their research proposals actually wound up. Some managed to do exactly what they had intended; others’ final projects bore almost no resemblance to those initial plans. They learned the importance of planning ahead, the value of duct tape and a soldering iron, and the importance of teamwork. They also gained the knowledge that at the end of the day, nothing cures your ills like fresh homemade bread. We as faculty could not have asked for more.
Ten years ago, the founders of Everett Community College’s Ocean Research College Academy (ORCA) received start-up funding from the Bill and Melinda Gates Foundation to develop a new model of interdisciplinary learning in a dual-enrollment, early college framework. Founding faculty (including Kveven and Searle) shared a commitment to the inquiry-based nature of science through student-driven projects that imbedded writing, mathematics, and historical context (Kveven and Searle 2008). ORCA’s early design reflected many of the conclusions reached by the most comprehensive collection of research on teaching and learning at that time: the National Research Council’s *How People Learn*. Founding faculty members also committed significant time to reflect, plan, and determine what students should know and be able to do at the end of a two-year, associate degree experience. The result was a vision statement that remains at the center of the ORCA experience: “ORCA is a community of active, responsible and inquisitive learners who grow through rigorous and integrated studies grounded in the marine environment.”

The vision continues to guide faculty and students alike, providing a strong focus yet allowing change in program design to better meet its goals for program and student success. As a result, what began as project-based research opportunities in select courses at ORCA has morphed into “scientific teaching” and a “research mindset” (Handelsman et al. 2007) over the entire two-year degree experience. Everyone in ORCA is an active learner who learns by doing (and sometimes failing), and every discipline involved is focused on creating a research mindset.

The ORCA model is a success. Everett Community College students at ORCA over the last ten years have achieved impressive degree-completion rates: nearly 85 percent of students graduate in two years with an Associate in Arts and Sciences degree, 95 percent go on to enroll at four-year
institutions, and 66 percent pursue majors in STEM fields (science, technology, engineering, and mathematics). ORCA has earned two National Science Foundation (NSF) grants for the construction of a research lab and the purchase of a new research vessel, and the program is a partner in a third NSF funded initiative aimed at increasing undergraduate research at community colleges. In addition, students must apply to the full-time, two-year, cohort-based program, and the growing number of students who want access to the program (there is currently a 60 percent admission rate), is another measure of success. The number of admitted ORCA students who conduct independent, original research and present that research at local, national and international events continues to increase, and results from end-of-quarter and end-of-year surveys confirm the extent to which current ORCA students and ORCA graduates have internalized the program’s vision statement and developed a research mindset that governs their approach to problem-solving and investigation in all disciplines. Together, these indicators point to a highly successful model of college education centered around undergraduate research.

To illustrate the powerful impact of ORCA’s unique interdisciplinary design, this chapter uses select student reflections to frame four important characteristics of undergraduate research: reflective learning, disciplinary integration, a research mindset, and relationship building. The student quotes are also intended to reflect the focus of an academic experience in which students are always at the center. It is our intention, through these student comments and our own reflection, to share successes, continuing challenges, and some of the lessons learned along the way as a framework for those interested in a similar, holistic approach to research as teaching and learning.

**Developing Reflective Learners**

As a start-up program applying the “learning by doing” approach, asking students to reflect on their learning every quarter and providing instructors with time each week to reflect on their work with students proved essential. Deliberate attention to student and faculty reflection during the process of learning elevated the value of reflection as a standard practice. The result is illuminated by the following student comment after her first year in ORCA:

*ORCA has given me such an incredible thirst to learn. My adolescent mindset of “I know it all” has changed to “I know little,” but I want to learn by doing research, hearing others’ perspectives, and applying my own understanding to problems or issues I face.*

The student’s comment reveals self-awareness as well as a core attribute of a future researcher—inquisitiveness. Based on student surveys and discussions, it appears that the majority of ORCA students arrive with an academically fixed mindset—the belief that their job is to find the “right” answer.
The undergraduate research experience at ORCA counters that mindset with inquiry-based research in which there is no right answer. Students have an opportunity to test whether the data they collect supports their own question or hypothesis. However, students cannot begin to work independently until they are actively reflecting on what they know, what they need to find out, and how they know what they (or others) know. Students must be given time to conduct this kind of reflection about data before they can internalize the ongoing nature of scientific and other intellectual research.

Faculty have similarly benefited from structured time for reflection. Each week, ORCA faculty members (tenured and adjunct) meet to share successes and challenges from the previous week, to plan future field experiences, and to discuss student feedback and student work. Mid-course and end-of-course survey results are shared and inform future approaches with students. Weekly faculty meetings, though admittedly a large time commitment, are immensely important to the program’s continued focus on its interdisciplinary vision.

**Disciplinary Integration**

The value of a focus on common disciplinary approaches is often revealed in students’ quarterly evaluations of the program:

*Now I am so much better at getting to the “whys” of the information I am given and figuring out what is important about it…. The analyzing and interpreting did not stop at humanities, though.*

*History helped me learn how to summarize, analyze, and interpret. Ocean Technology has taught me how to interpret data on a graph, and it has taught me how to analyze the data in a concise and organized manner. The humanities class has helped me to learn how to analyze, interpret and understand perspectives of different authors. This class has also taught me how to write a paper with a beginning, middle, and end that is actually insightful and intriguing.*

Significant faculty planning time to think reflectively about disciplinary overlap led ORCA faculty members to develop, over time, cohesive approaches to shared learning outcomes. Key was the realization that every discipline has at its core the use of evidence to support ideas, regardless of whether the evidence comes from data, literature, primary historical documents, or mathematical proofs. A second realization emerged when instructors looked beyond specific disciplinary content to identify three skills used by successful students in all of their courses: summary, analysis, and interpretation. Over time, instructors have adopted this common language in their courses. The ORCA experience over the past ten years shows students more easily transfer the process of summarizing, analyzing, and interpreting from one discipline to another when all faculty members at ORCA use similar language and clearly articulate when and how different disciplines approach problems in different ways.
The student who sees her own growth in “getting to the whys” has also benefited from a question that can be heard posed by instructors and students in any classroom at ORCA: “What’s your evidence?” The question appears obvious, but the challenge for instructors and students is to have an existing framework that allows students opportunities to ask relevant questions that can then be tested. Students have space and time to test their own ideas in all disciplines, and instructors trust that student questions, with guidance, will ultimately lead students to the required learning objectives. Instructors have deliberately chosen course materials that lead students to the required learning objectives. Students studying a primary source document from the Progressive Era, for example, must draw conclusions based on the text in front of them, even if it challenges students’ preconceptions. Similarly, students analyzing the salinity profile from a probe deployed at the mouth of a local river must grapple with the data showing seemingly contradictory levels of salinity at the surface and at lower depths. As long as students and instructors remain focused on the data, and as long as students are given the time to explore the data on their own, our experience suggests this approach is a powerful way to deliberately and organically integrate student learning.

Integration based on a shared set of skills related to research, careful scaffolding of levels of difficulty and independence, and faculty commitment to the same vision for student outcomes have all increased the depth of learning at ORCA. Students report feeling empowered to ask more questions and to engage in constant reflection to improve their understanding in all disciplines. Faculty feel liberated to focus on the most important outcomes in each discipline. They have more time to focus on the key questions in their courses because students more readily transfer the skills and strategies for learning from one class to another. Rather than re-teach the basics of summary, analysis, and interpretation each quarter, instructors build on previous class work. This allows for a faster immersion into each discipline each quarter and provides students with a continuous and intentionally scaffolded learning experience.

**Research Mindset**

One ORCA student describes having a research mindset this way:

_I will probably never be able to go near a body of water again without wondering about the depth of the halocline and the thermocline and asking myself what is affecting the water column in that particular area. This process of asking questions will help me in the future as I continue to grow and learn._

One of the most empowering acts of an instructor is to elicit student questions and then provide students the tools, time, and guidance to seek their own answers to these questions. Asking pertinent questions demonstrates critical-thinking skills and a research mindset; in ORCA science
classes, these questions center on the local marine environment. The State of Possession Sound (SOPS) project, a long-term monitoring project on our local body of water, allows first year students to collaborate in small groups by collecting and analyzing data. Connections are made across the science curriculum as field experiences, labs, and class time are designed to build the necessary skills to support students in asking more sophisticated questions. Monthly SOPS cruises allow students to master boat-based data collection that adds to the existing database. While a group may use an instrument to collect salinity and temperature data at increasing depths in the field, laboratory activities provide opportunities to model what is difficult to visualize in the field by using partitioned tanks or by focusing on graphing data in Excel. Class time, however, is spent discussing the data, and most importantly, asking questions that may develop into research projects. Students, in this example, quickly discover that salinity not only varies with depth, but also by location, tide stage, or river height, which raises even more questions. The students are further engaged when given the opportunity to conduct scientific research related to some of these follow-up questions. Combined with their growing capacity for reflection and their growing familiarity with an expanding data set, ORCA students in their first year develop a research mindset that prepares them for more independent research during their second year in the program.

Building Relationships

As a student from ORCA, my experience was enriched by the SOPS cruises we were able to go on each month. The SOPS cruises are what ORCA students live for... the amazing hands-on experience of being research scientists in the field. ... SOPS cruises are instrumental in building the sense of community between students and faculty, while developing problem solving, teamwork, and communication skills.

The student quote highlights two key characteristics of undergraduate research at ORCA: student ownership of research and the supportive relationships that are built among peers and with the faculty. As much as faculty members work to empower students to become independent researchers, faculty members are also determined to illustrate how research in all disciplines is ultimately collaborative. All research builds on the work of other researchers, and research today often requires teams of people working together. Thus, building relationships among students and between students and faculty is an important goal of the program. ORCA’s two-year, cohort-based design allows students to get to know each other well; similarly, facilitating instructors’ relationships with the same group of students over multiple quarters increases the extent to which instructors know their students well and vice versa.

It is during field excursions and an annual retreat, however, that faculty and students form the best connections with each other. Whenever possible,
all ORCA instructors participate in the monthly State of Possession Sound (SOPS) research cruises. All faculty attend the two-day, opening retreat for each new cohort as well as the two-day field excursion to the Olympic Peninsula for first year students in the program. Faculty members attend and participate in program trips to local art museums and evening talks. Each of these experiences reinforces for students the idea that they belong to this college program and that learning happens all the time, rather than only during class time. Each quarter students identify their relationships with each other and with faculty as an important part of their ORCA experience.

**Challenges and Lessons Learned**

Anyone endeavoring to transition from traditional teaching to an undergraduate, research-focused project or program is aware of some of the difficulties. The introduction to *Broadening Participation in Undergraduate Research* (Boyd and Wesemann 2009) identifies passion and commitment as key to pursuing the vision of the increased student learning through undergraduate research. Our passion and commitment have proved infectious for students and faculty, and our graduation/matriculation rates reinforce the efficacy of the program. Our students continue to report that the research mindset they have developed at ORCA builds their confidence as they transition to further opportunities at regional universities.

From the beginning, ORCA faculty have learned the best way to counter challenging budget cuts or shifting goals at the college is to bring key decision-makers to showcase events or class presentations. The student work is impressive, as is each student’s ability to communicate his/her findings. Clearly, timely support such as the NSF grants have helped, but equally important is the attention given by faculty to cultivating connections with members of the local community, some of whom have provided additional financial grants to help low-income students with textbook scholarships and to offset costs associated with excursions to the field. These smaller grants are the result of deliberate networking in the local community.

Whether an undergraduate research program is a holistic, two-year, integrated program like ORCA or an instructor-focused project, local topics are a tremendous source for undergraduate research questions. ORCA has forged partnerships with county and state agencies for local research. Faculty members have also found that holistic ecosystem monitoring incorporates a broader perspective that is conducive to curriculum integration. In addition, ORCA students’ motivation increases when study sites have a local connection.

Other two-year colleges can be helpful resources, and we leverage networks within our nearby two-year colleges for showcase events
and conferences. Since two-year college students stay in their communities, these community connections stand out and make a lasting impact on our students (Mullin 2013). When students present their work within the community, the level of confidence in their work improves due to positive feedback from interested parties. This also often catalyzes the network of connections students need to earn an internship or gain access to a lab experience at their next institution.

ORCA faculty members continue to experiment with different ways to collect evidence of student learning. Though a number of nationally recognized surveys exist to assess students’ shifts in feelings about research, we have yet to find one that fully assesses the holistic learning gains sought in our program. Thus, we continue to rely on student self-reporting and faculty assessment of student work. We have begun to look more deliberately at the change over time for individual students in their quarterly reflections. Now, at the end of the first academic year, we can look at individual student growth as a function of their progress in becoming active, responsible, and inquisitive learners in all their classes.

Finally, a majority of the literature indicates that persistence leading to completion at two-year colleges occurs when students feel connected to the college through a program. Undergraduate research is a well-defined avenue to increase that connection. Our experience supports the hypothesis that students are more committed to completing their degrees when they feel a strong connection to their college, to their faculty, and to their fellow students. These relationships energize students, increase the level of student responsibility, and build the critical problem-solving and teamwork skills employers seek. Faculty benefit too. Strong faculty-to-faculty relationships provide a significant level of support for challenging work that requires tremendous amounts of time. Faculty members learn about each other’s disciplines at a deeper level than ordinary professional development provides. The connectedness from achieving shared goals of increasing the critical-thinking and problem-solving abilities of students sustains ORCA faculty throughout the academic year.

The ORCA model requires a reimagining of teaching and learning in community colleges. Its success is the product of passionate individuals committed to reflection, disciplinary integration, a research mindset and relationship building. Students benefit from the relationships forged in a cohort-based system and with a common core of instructors over two years. Ultimately, the ORCA model is a success because it has identified a framework of values rooted in the intellectual and practical approach of scientific research, applicable in all disciplines and relevant to students’ lives beyond their college experience.
ORCA combines the last two years of high school with the first two years of community college. This early college framework utilizes a dual enrollment program in Washington State called Running Start where high school juniors and seniors are eligible to take classes tuition free at community colleges. ORCA has created a magnet, two-year program with a predetermined series of courses that meets humanities, social science, and natural science requirements for an associate of arts and sciences degree. Students apply for admission from regional high schools to work collaboratively with the same cohort of students and the same core faculty. For more in-depth programmatic information, see CUR Quarterly Summer 2013 available at http://www.cur.org/assets/1/23/Summer2013_V34.4_Kveven-Searle_Web.pdf.

Students apply to the program and are admitted through a holistically reviewed application process. Successful candidates are students who are ready to become active, responsible and inquisitive learners and demonstrate this through two essays that address evidence of persistence and ability to overcome challenges. College readiness placement exams in mathematics and English are also utilized along with a letter of recommendation during the comprehensive review.

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The Community College of Denver (CCD) is a member of the Colorado Community College System (CCCS) and a leading point of entry to higher education for students in the metropolitan Denver area. Its vision is to expand access to higher education, particularly for underserved, first-generation, socioeconomically disadvantaged, and minority students. Indeed, nearly 45 percent of its students are first-generation college students. Its service area encompasses the Denver Public Schools (DPS) district, where approximately 80 percent of the students are ethnic minorities. Located in downtown Denver, the community college shares a campus with the Metropolitan State University of Denver (MSUD) and the University of Colorado at Denver (UCD).

This setting offers CCD students access to a world-class research university library (at the University of Colorado), among other amenities that are often not available on community college campuses. CCD is the only Hispanic-serving institution in the metropolitan Denver area. CCD has a strong dual-enrollment agreement with Denver Public Schools, under which it provides college-level classes in local high schools. The college has transfer agreements for majors in STEM (science, technology, engineering, and mathematics) fields with every four-year college in Colorado, as well as awarding associate of science degrees in general science; students can emphasize studies in biology, chemistry, environmental studies, mathematics, nutrition, physics, and engineering. Between 2007 and 2013, the college’s enrollment in STEM fields grew 64 percent. The Center for Math & Science (CMS) is focusing its growth and development on strong transfer pathways in STEM fields and is pursuing activities, courses, and resources to shape a robust set of opportunities for transfer-bound students. As a way to stimulate interest in advanced studies in the science, it offers a number of avenues for students to pursue undergraduate research.
Individual faculty and departmental efforts to create and sustain an emphasis on research include integrating research into laboratory education; incorporating critical thinking and research projects into individual courses; developing a seminar series featuring principal investigators at the Anschutz Medical Center of the University of Colorado at Denver; and offering independent studies, hands-on grant-funded activities, poster presentations, and honors projects.

**Research Opportunities**

Among other support, CMS receives funding from the National Aeronautics and Space Administration (NASA) for Rocket Day at a local elementary school, where students learn to build and launch rockets, and for balloon satellite research, through which students have built, designed, and launched data-gathering balloons, collected data, and analyzed and reported on it. Funding from the National Institutes of Health allows students to do biomedical research, write publications, and find work in labs after their training periods conclude. Opportunities for CCD students to explore STEM fields in greater depth than is available in typical two-year programs are being created through a partnership with the University of Colorado at Boulder and its Denver campus. The partnership, currently in the planning phase and funded by the National Science Foundation (NSF), will allow students from the sixth grade through graduate school to participate in authentic laboratory research using research-grade equipment. Given this rich set of research-focused opportunities, CCD also began exploring ways to incorporate research into regular undergraduate courses.

In spring 2012, an interdisciplinary team of faculty members, adjuncts, and an administrator attended a Council on Undergraduate Research (CUR) faculty-development weekend focused on incorporating research into the community college classroom. When the team began this experience, its goals were that:

- Administrators and faculty members should value and actively support student research.
- A culture of research would become a part of the identity of CCD, increasing student engagement and better preparing students to succeed.
- Every student should have multiple opportunities across the disciplines to acquire knowledge about basic research and critical thinking.
- Every student should have the opportunity to participate in hands-on research using a variety of methods.
- Student research should have personal applications, increase understanding and retention of subject knowledge, and enhance the enjoyment of learning.
Challenges to Implementing Community College Research

Fortunately, at CCD the administration strongly supports building in research opportunities for students. Without this institutional backing, much of the work that has been done would not have been possible. Nevertheless, significant challenges have had to be overcome thus far. First, for students, transferable credits for research experiences matter because if courses are non-transferable, students are investing time and paying tuition for course credits that might not serve their further academic pursuits. But students may ask, if research is optional, why do it? Although the college sees the connection between research and students’ intellectual and career advancement, students may not. CCD needed a mechanism for students to earn transferable credits for their research experiences. Fortunately, a flexible course-numbering system used by the Colorado Community College System provided an opportunity for CCD to pilot a research course for two semesters that carries transferable credits.

Because CCD is a teaching college, the institution also needed to be very clear on how it would handle faculty members’ workloads; a standard base teaching load is 15 hours per semester. Pulling faculty from the classroom to do work that is not directly instructional has fiscal costs and must be fair to other instructors. Classrooms and laboratories are structured more for a 110-minute class period than for the more open-ended timeframe of scientific discovery. However, it was the financial capacity to do large-scale research at CCD that was the primary challenge. Without substantial research funding, capacity to generate new knowledge was limited. Within the physical and natural sciences, especially, the ability to conduct quality research can be inextricably linked to having the resources necessary to provide access to equipment and materials. Yet, CCD had little equipment in place for researchers’ use. To establish the pilot course then, equipment and reagents had to be purchased and a lab set up. In addition, safety concerns required that safety protocols be developed and constantly updated to reflect the variety of activities that students undertake in the CCD research lab. Thus, the pilot course, in biology, was designed to be adaptable, not rigidly structured.

Before CCD could begin developing the course-level research experience for students, faculty had to align the activity with the institutional philosophy, goals, and purpose. The team mentioned above collaborated to define what research is in the context of CCD’s mission and focus as a teaching institution largely serving first- and second-year students. At that point in their education, CCD students are largely untrained; as a result, faculty have designed a research-development strategy that is heavily focused on transmitting skills and good habits so that students can transfer as juniors with the skills to work in labs immediately upon entering their four-year institution. Research at CCD uses a method of discovery-based learning
in which the student potentially could produce original findings worthy of publication or presentation; however, the focus of the experience is on learning the processes and modes of thought and analysis that researchers require. Thus, research is seen as a teaching and learning experience rather than as a vehicle for faculty scholarship.

**Conceptual Model**

At the core of the undergraduate research activities at CCD was a four-pronged model designed to provide freedom and flexibility for the pursuit of research while conforming to the structural and logistical realities of the college. This design was developed in the absence of a holistic logistical, academic, and structural foundation upon which good research activities may be constructed.

The first prong of CCD’s plan emphasized the development of a new class in biological research methods. The heart of the class focused on what it would be like to be in a graduate-level laboratory, only without the “publish or perish” pressure of a graduate lab. The learning model intentionally included no points and no exams. Evaluation was delivered through a mentored relationship in which students were free to practice a particular skill and then be orally evaluated by the instructor. The purpose was to remove the common stresses that students feel in exams and move them from grade-chasing to a more dynamic, mentored relationship with the instructor in which their success was based on their progress and abilities. This design fostered an atmosphere that allowed students to relax, have the freedom to learn and make mistakes, and learn from those mistakes. This first activity was launched in spring 2013, with the initial offering of the pilot course planned for fall 2013.

The second prong of the undergraduate research plan involved integrating this methods class with other biology classes. The methods class at CCD focuses heavily on students designing and working on an independent project that they develop with their research instructor. The instructor teaches skills and techniques that students can transfer not just to research labs but also to learning material in their other classes. Thus, a student who is taking the methods class and a microbiology course at the same time can use the skills learned in her/his methods class to do a microbiology project. For example, the student can work on a project in collaboration with the research instructor and the microbiology instructor to create a small learning community with a great learning opportunity. In this fashion, students can learn in greater depth the ideas and concepts from one class and bring that knowledge to share with their research classmates in a lab meeting presentation. The intent is to encourage students to merge their learning from
the other courses in the department into a more cohesive experience and create a deeper, richer learning opportunity for the students in all courses, not just the research methods. This second prong of activities was implemented in spring 2013 and fall 2013.

The third prong is to define how this research-methods course can create interdisciplinary collaborations. This requires a well-developed methods class with better-developed research projects, so faculty aim to construct a learning community and a close collaboration between instructors. For example, a statistics instructor could work with the biology research instructor on an environmental project in which a biology research student designs an experiment and collects data. The statistics student would analyze the data numerically, applying his or her academic skills to real-world situations. The students would collaborate to develop interpretations of the data to explain the research activities. The goal is to expand the instructor/student collaboration to produce interdisciplinary research projects. This prong of implementation is expected to roll out in fall 2014.

The fourth prong is based on inter-institutional collaborations, with a focus on reaching out to other campuses, largely four-year universities and some other community colleges in the Denver area, to create partnerships to extend research opportunities for CCD students. Toward this end, CCD currently has principal investigators and post-doctoral fellows from the University of Colorado at Denver’s Anschutz Medical Campus offering seminars to CCD’s research students, sharing their expertise and cutting-edge findings. The goal of this activity is to shape a collaborative research project as the research class matures. If CCD students can envision their work within the larger scientific research enterprise, we anticipate they also can imagine themselves as part of a four-year university and graduate experience, as well. This effort got under way in fall 2013 with a seminar series featuring four biomedical researchers.

**Gauging the Student Experience**

Students were generally positive about their experience in the pilot semester of the course in fall 2013; participants describe authentic learning gains as students of science and express interest in additional research opportunities. One adult female student described the impact of her experience:

“I wanted to do more….with cloning practice making gels and see better results with [my] % of errors decreasing. …. [I appreciated] the opportunity to actually be in a working lab, especially in the beginning. It allowed me to truly see and experience the outcomes of running [experiments]. …. The strong points are the ability to deepen our lab skills, practice experiments again to obtain important information re: errors and probabilities for
correcting them, and gain better understanding of how each component of the experiments work[s] to enhance the outcomes."

Another adult student observed:

“The more tactile experience this course offers has dramatically increased understanding of the conceptual mechanics of biology and chemistry. It also grants a preliminary sense of what a career in laboratory research might be like, offers the opportunity to generate and carry out a project in the prospective career field that is being pursued. This can give the student a very competitive edge with future employers and future academic work/endeavors.”

A third, younger female student found her experiments “extremely fascinating and … an unbeatable hands-on way to learn. I also really enjoyed the chalk talks about molecular DNA bio.” This student fully grasped the relationship between literature review and detailed knowledge of science. “I think being assigned to read chunks of many different research papers on varied topics would have been very beneficial, maybe add that in the future,” she suggested.

Students also came away with a clear sense of the challenges in doing scientific research. They were frustrated by time pressures, fiscal and physical constraints, and lack of personnel to keep the lab open longer each day. Another student noted that there was, “Not enough lab time for a student with a busy, go-all-day schedule. There is not time outside of class for labs.”

**Future Steps**

Since CCD is still very much in the early stages of developing this focus on undergraduate research, many future challenges and opportunities lie ahead. Of immediate importance is the development of the research experience and getting it to work seamlessly within the framework of a class structure and schedule. The faculty will need to establish IACUC (institutional animal care and use committee) protocols to help define what student researchers can humanely and ethically do when using research animals such as zebra fish and mice. Faculty members are interested in pursuing grants to expand project opportunities; in lieu of external funding, faculty will seek lower-cost research projects. The interdisciplinary focus is another growth opportunity. Over the coming year, focus will be on developing the second and third prongs of the current project by working with chemistry and physics faculty members to generate more research opportunities to support a broader cross-section of students. Other hurdles include the logistics of running a lab and keeping it accessible so that students can get their work done, as well as increasing the buy-in of faculty for the project and resolving questions of faculty teaching loads.
Despite the interest of certain faculty members and departments, CCD still lacks a college-wide, comprehensive institutional vision of undergraduate research as a critical competency for students. To establish what this competency might look like, CCD needs better understanding of where good models exist from which it can draw best practices. But the good will of the college administration, the interest of specific faculty members, and the enthusiasm of CCD students are all motivators in keeping this activity alive.
The Green Fuels Depot (GFD) is a collaborative project involving the College of DuPage, the City of Naperville, Illinois, the Argonne National Laboratory, and Packer Engineering designed to establish a sustainable energy source based on the gasification of community-generated yard waste. The role of the College of DuPage in this project was threefold: to develop training and educational materials for future operators of the depot; to mentor and train students in the operation of the depot’s equipment; and to perform basic research on the gasification process. More broadly, this project was aimed at incorporating educational material into the chemistry curriculum designed to increase students’ awareness of sustainability issues.

The College of DuPage (COD), located thirty miles from Chicago in Glen Ellyn, Illinois, serves approximately 31,000 highly diverse students—both traditional and non-traditional—on the largest single community college campus outside the state of California. More than 2,000 students take chemistry classes at COD annually, mainly science majors and health-science majors. COD currently has about 21,600 square feet of laboratory space dedicated to the chemistry program, with access to an additional 1,000 square feet, as needed, for classes. The department has pursued a number of initiatives over the past few years aimed at increasing student success in the discipline and retaining students as science majors. Undergraduate research has been a significant focus of these initiatives.

The report Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics (STEM), published by the President’s Council of Advisors on Science and Technology (PCAST) in 2012, identified the need to produce approximately one million more college graduates in STEM fields over the next decade. It noted that fewer than 40 percent of students who enter college intending
to major in a STEM field actually complete a STEM degree. The PCAST report also identified the first two years of college as the most critical to the retention and recruitment of STEM majors. Community colleges have an increasingly important role to play in the education of future STEM graduates, since almost half of all graduates with STEM degrees have attended community college.

Undergraduate research has been identified as an important activity in attracting and developing STEM students. From 2006 to 2011, I directed the college’s Undergraduate Research Collaborative (URC), a project funded by the National Science Foundation (NSF). Other college partners included the City Colleges of Chicago, William Rainey Harper College, and Oakton Community College. Informal agreements to host summer students and/or build faculty collaborations were negotiated during the project among representatives of the College of DuPage, the Argonne National Laboratory, Northwestern University, and the McCrone Group, which is a company specializing in microscopy and analysis in Westmont, Illinois.

The goals of this project were to:

- Identify and recruit promising young scientists from two-year colleges into the STEM disciplines, especially students from traditionally under-represented groups;
- Train two-year college students to become effective practitioners of science;
- Instill in two-year college students the confidence to pursue science as a profession;
- Encourage two-year college students to complete their undergraduate and graduate education in STEM fields; and
- Transform the cultures of participating two-year colleges by embedding intensive research experiences during the academic year and summer into their curricula and their courses.

The impact of the URC on transitioning students from community college to a four-year university has been described in a number of publications (for example, Higgins et al. 2011). Our experience at COD was that the most effective component of the URC was the participation of students in summer internships at national laboratories and universities, local and national. For example, four students were able to participate in the highly competitive, prestigious Research Experience for Undergraduates (REU) program at the Materials Research Science and Engineering Center (MRSEC) at Northwestern University. Many other students participated in the Community College Institute (CCI) program through the Department of Energy at Argonne National Laboratory and Fermilab, in which students were able to participate in national meetings of the American Chemical Society and present the results of their research to hundreds of other
scientists. In many cases, these students transitioned directly into undergraduate research programs at their transfer institutions. Several students’ career pathways were influenced by the experience. A number have subsequently entered postgraduate research programs. None of the participants’ career goals in science were untouched by the experience.

The Green Fuels Depot

During the later stages of the URC program, other initiatives involving undergraduate research and internships were investigated. For example, beginning in late 2010, a few students and I had an opportunity to participate in a collaborative project based on the development of a sustainable energy project known as the Green Fuels Depot (GFD), in Naperville, Illinois. Other partners in the project included Packer Engineering, a Naperville-based engineering company that had developed the technology to be used, and the Argonne National Laboratory, which has extensive interests in a broad range of renewable energy projects. The depot project was aimed at demonstrating the viability of integrating renewable-energy reclamation technologies to transform yard waste into a series of energy streams for use in local communities. The long-term goal was to enable communities to become self-sufficient in transporting energy using cost effective technologies for the conversion of locally supplied yard waste and other biomass (such as switchgrass and corn stover), while simultaneously reducing greenhouse gas emissions and fuel costs.

This project provided the college a unique opportunity to engage with the local community to develop something of lasting social significance. Naperville, Illinois, has been a leader in promoting responsible use of energy. It is a participant in the U.S. Department of Energy-funded Smart Grid Initiative. The city recognized the potential of the Green Fuels Depot to expand awareness in the community of the future role of sustainable energy sources. Further, the project offered educational opportunities for students at COD and, with the emphasis on biomass, provided an opportunity to demonstrate the role of chemistry in renewable energy.

Students were mentored in the developmental phase of the GFD in the summer of 2011. Under faculty supervision, students worked on developing operating procedures and performing research on aspects of the gasification process. Other products of this work included a proposal submitted by the author for a Green Fuels Depot certificate, which would be awarded by the College of DuPage to potential Green Fuels Depot operators, and a new chemistry course titled Scientific Concepts in Sustainable Energy with an anticipated launch date of fall 2014. In the future, it is hoped that the depot will provide service-learning opportunities for students from a range of disciplines who are interested in environmental studies. One current example
is a multidisciplinary honors class combining environmental biology and literature that focuses on world food practices.

Selecting Student Participants

Two students were selected to work on the project over the summer. The project’s budget allowed them to be paid at the same rate as experienced student workers at the College of DuPage. Recruitment began the previous winter by having faculty in the sciences publicize this research opportunity in their classes. Interested students were directed to contact me for further information. Some other students sought me out individually. Candidates were invited to come for an informal interview. The selection process was not heavily structured. I would attempt to ascertain candidates’ career goals, previous experience (if any), level of interest in sustainability and renewable energy, and what students thought they might contribute to the project. They were not required to submit a letter of reference, and their academic record was not considered. Overall, the candidates impressed me with their interest in contributing to a sustainable energy project. The final selection came down to identifying who would work best in a team environment in which a lot of independent work and initiative were required.

Project Overview

Gasification of carbon-based materials—in which both the temperature and the atmosphere of gasification determine the composition of the products—has a long history and takes many forms. In the Green Fuels Depot project, the objective was to maximize the energy content of the products by using a combination of high temperature and anaerobic conditions. Under these conditions, cellulosic material is converted into a mixture of carbon monoxide and hydrogen (syngas). Syngas represents a flexible source for a range of transportation fuels.

The project ran for ten weeks beginning Memorial Day in 2011 at Packer Engineering in Naperville. The College of DuPage group, consisting of the two students and me, worked with engineers at Packer on many different aspects of the project. The main goal was to assemble a prototype gasifier to be delivered to the City of Naperville for the opening of the GFD in November. While the overall design was already in place, and most of the hardware ordered, many practical aspects of the process needed to be investigated and many technical questions addressed. In addition to the technical work, the team from the College of DuPage was assigned to develop operating procedures and training manuals for future GFD operators. The activities undertaken are summarized below. In almost all cases, there were no existing protocols to follow. While Packer Engineering was able to provide hardware, the team needed to develop methodology to solve problems independently.
Specific Student Activities

The students worked on a diverse range of problems, including the following:

- Analysis of discarded metal in woody biomass. It is important to identify the sources and types of metallic material in the biomass that potentially can damage the gasifier.
- Identification of specifications for hydrogen storage in a prototype fuel-cell-powered, radio-controlled car. The goal of this activity was to investigate alternative forms of solid-state hydrogen storage and demonstrate hydrogen-powered transportation on a small scale.
- Testing gasifier ash for liquids content. The Environmental Protection Agency requires testing of the waste for liquids using a standard test, EPA 9095B.
- Analysis of water content of Naperville wood. The gasification process requires the water content of the biomass to lie within a specific range; usually the yard waste has a higher water content.
- Testing of different sizes of switch grass as an alternative biomass source. While not directly relevant to the Naperville Green Fuels Depot, the potential for replacing the biomass fuel with switch grass was investigated for application of the GFD in other regions.
- Determination of rock and mineral components in Naperville biomass. Solid waste from the gasifier was analyzed for these materials, which can damage the equipment.

The team also developed a number of documents and manuals including a gasifier operating procedures manual, a description of the skillsets of a GFD operator, periodic inspection protocols, a summary of key thermodynamic quantities in the gasification of biomass, and a description of the important chemical processes involved.

Based on the college’s experience with the GFD project, a new course called Scientific Concepts in Sustainable Energy was developed, designed to increase students’ awareness of sustainability issues. It was approved by the Illinois Community College Board and was scheduled to be offered in the fall semester 2014. The course will offer a non-mathematical approach in examining a range of sustainable energy sources, including wind, solar, ethanol, biodiesel, gasification, geothermal, hydrogen, and fuel cells. For the longer term, anticipating the need to produce trained operators of the GFD (or similar types of local energy technology), a curriculum for a Biomass Energy Technology Certificate was drafted, which would involve twelve technical courses for a total of thirty-three credit hours, which would need to be approved first by the College Curriculum Committee, and subsequently by the Illinois Community College Board.
Challenges

The significant challenges to conducting a project of this nature include recruitment and management of students, identification and management of roles and responsibilities in a complex, loosely structured partnership, procurement of funding, and maintaining long-term project viability. The faculty member will have the most control over the first of these challenges, but perhaps very little over the others. As described, a relatively unstructured selection process was used to select the students in this project. Having used the same approach successfully with more than thirty students during the course of the Undergraduate Research Collaborative, I feel that such an approach can work well, and I would use the same approach in future projects of this nature. Although, of course, if a student does not live up to expectations, it can present challenges to a successful experience. It is greatly to the benefit of the project if students are indeed capable of thinking independently and pursuing tasks without supervision.

The GFD project presented a particular challenge in the organization and dynamic of the partnership. The partners in the group were all independent entities with no formal connections. While the roles of each partner were broadly identified and agreed upon during preliminary meetings, no formal reporting systems were established. The project would have benefited from more structured project management. The interaction between the college group and Packer Engineering was complicated by the fact that the overall project director at Packer had no day-to-day involvement, while the Packer engineer responsible for developing the equipment had not been involved in any of the prior discussions about college’s participation over the summer and had not been apprised of the team’s arrival. Needless to say, this did present some challenges initially in working together. It is important for all parties in a collaborative arrangement to be fully cognizant of the personnel involved and their respective roles and responsibilities.

Funding, of course, is almost always the limiting factor when planning a research project. It is highly unlikely that the community college will be the source, particularly on the scale required for a project of this type. Thus sufficient time must be allotted beforehand to identify and procure funds. While the actual work began in May 2011, the search for funding began in early 2010. Funds eventually were obtained from the Department of Energy with the aid of Congresswoman Judy Biggert. The process involved many months of budget negotiations with the department, mostly involving identifying and agreeing upon matching funds. It is essential to have at least one team member very conversant with the contract-negotiation process involving government agencies.

Another challenge relating to funding is establishing long-term viability for the project. In most cases, external funding is for a finite period, requiring that other sources of support eventually be developed. While
much benefit was derived for the community college during COD’s active involvement in the GFD project, greater benefit is anticipated when the technology is commercialized. It is expected that students would be hired by companies using this technology and that enrollment in the relevant classes would grow. Furthermore, the community will benefit from the economic growth that would accrue from local companies commercializing the technology. It is expected that the technology can have global impact. Long-term viability also depends on the stability of the partnership and is vulnerable to changes in business strategies of any of its commercial partners. The community college is unlikely to provide financial support for faculty involvement or to maintain equipment. Unfortunately, further progress in the GFD project has been threatened because one of the partners no longer can afford to participate in the project, so currently the long-term future of the project is unclear.

References

Biofuels Grant to Rend Lake Community College Supports Undergraduate Research

Linda Denton, Caroline Ragan, and Mark Jornd

In 2010 Rend Lake Community College received a New Era Technology Grant from the U.S. Department of Agriculture to provide undergraduate research experience and help train future workers in the biofuels industry. The grant-funded program consisted of three parts:

1. An new, elective undergraduate course on biofuels
2. The creation and supply of a biofuels lab
3. Interdisciplinary research projects for undergraduate student interns

Once funded, the Rend Lake faculty team, added a fourth element to the program; they devised a plan to incorporate lab and analytical skills from the biofuels program into the capstone Biology II course taken by all science majors on campus.

The two-year project hired a total of eight interns (four interns per year) who worked twenty hours per week for two semesters. The interns were selected through a competitive review process from the departments of agriculture, engineering and science at Rend Lake. Students were chosen based on academic strength and the ability and desire to dedicate the necessary time to an intense research project. In order to apply, candidates had to be eligible for the Rend Lake cooperative education program. The selected students were paid through the grant and also received co-op course credit. Candidates applied as freshman and performed the work during the summer and fall of their sophomore year.

Biofuel Internships/Cooperative Education

Research projects were selected and designed by the faculty advisors. The intern research projects included three segments:
Biofuels Grant to Rend Lake Community College Supports Undergraduate Research

- Production of ethanol using four different cellulosic feedstocks along with common yeast and fungi to duplicate possible farm-based production.
- Determination of reducing sugars produced from corn stover under various treatment options.
- Economic analysis of the use and production of biofuels on a typical Southern Illinois farm.

The first group of four interns began their work in the summer of 2011. Through experimentation and analysis, they studied the feasibility of ethanol production from four cellulosic feedstocks easily grown in Southern Illinois, with saccharification and fermentation processes using readily available fungi and yeast.

The second group of four interns began their work in the summer of 2012. They conducted a series of experiments to determine the production of simple sugars from corn stover using combinations of physical, chemical and biological treatments to support processes required for ethanol production.

A number of instrumentation and laboratory challenges were experienced over the course of the project. The team demonstrated creativity and ingenuity to meet those challenges and stretch funding. For example, on-hand physics turntables were repurposed with model electric motors to form rotators for the fermentation process. The college’s spectrophotometer was not sensitive enough to measure simple sugar concentrations in solution, so a for-profit research lab was used to analyze the students’ resulting liquids for ethanol. Unfortunately, the company was unable to assist in the second year, so the team identified a sufficiently accurate titration method to complete the same analysis. These adjustments and accommodations gave the interns exposure to a wide array of laboratory techniques and vividly demonstrated the importance of flexibility in research.

The program interns were expected to master several basic laboratory skills such as dilutions, fungal cultures, aseptic techniques, quantitative assays, and the operation of a spectrophotometer. All students were supervised and required to practice these skills in order to receive course credit. In the first year, supervising faculty determined that several, more advanced laboratory techniques were critical to the proper use of fungi. The second intern cohort mastered these additional techniques.

In addition to their work in the laboratory, all interns were expected to:

- Perform a literature review of scholarly articles and write a summary relevant to their planned project.
- Conduct the experiments.
- Collect and properly analyze their data.
Write a technical report correctly describing the experimental procedure and effectively communicating the conclusions derived from the data analysis.

Typically, undergraduate research projects devote significant effort in the first year to develop the study’s foundation. Once established, focus can shift to experimentation and analysis of data. Following that pattern, our first year placed more emphasis on the literature review and technical writing to establish the program’s foundation. In the second year, more emphasis was placed on the laboratory and experimental skills. Interestingly, the interns’ achievements mirrored the faculty advisors’ emphasis. Faculty advisors spent many hours mentoring the first-year interns on proper reporting techniques; as a result, the first-year group produced reports superior to those produced by the second-year interns. Reflecting a similar pattern of emphasis, the second-year interns developed superior laboratory and analysis techniques when compared to the first year.

Rubrics were developed and used by all faculty advisors to measure achievement on the established program goals. All eight interns required intensive mentoring to complete their goals with an acceptable rubric score above 60 percent. Six of the eight interns had not previously completed a college-level science laboratory course and required more extensive coaching to complete an acceptable report. First year interns earned final report scores of 66%, 86%, 96% and 80%; second year interns earned report scores of 60%, 60%, 64% and 80%.

Biofuel Research in Biology II Curriculum

College Biology II is a capstone class for all Rend Lake science majors. The biofuels research and related laboratory techniques complimented the course’s evolution and biological diversity curriculum. In collaboration with Southern Illinois University research professors in the departments of zoology and plant biology, laboratory skills required to conduct scientific research were identified and developed into assessed activities.

To determine College Biology II student readiness, a laboratory skills pretest was administered at the beginning of the semester. The assessment took place with a group of seven students in the spring of 2012 and 10 additional students in the spring of 2013. The original skills list was augmented to reflect student weaknesses revealed through the pretest scores.

The small class size and proficiency level required to demonstrate lab skill mastery fostered competition and camaraderie among the students. Interestingly, the competition seemed to enhance interest in the course. For example, one student struggled with culture plate streaking technique, repeating the steps six times before he gained proficiency. The instructor walked a delicate line, coaching the student and managing the robust
encouragement offered by fellow students, while not embarrassing or pressuring the struggling student. Ultimately, this student achieved the top score for the skill on the post-test.

The pre-test and post-test assessment required that the students demonstrate proficiency of each skill. For the 2012 students, the pretest mean of 56.8 was followed by a statistically significant improvement, with a post-test mean of 89.9 ($t = 9.3621$, 95 percent confidence level). Results for 2013 were similar, with a mean pretest score of 54.10 and mean post-test score of 82.00 ($t = 12.9631$). Post-test means from 2011 (prior to undergraduate research) were compared to those of student researchers in 2012 and 2013 but did not show a significant difference.

Various challenges surfaced as the class progressed through the semester. Lab periods were sometimes too short to accommodate exercises with a standard curve or multi-step assay. Careful instructor planning and adjustments were necessary. Fungal cultures were often contaminated because of students’ inexperience with the material. Students often lacked the patience and maturity to cope with the painstaking nature of laboratory research and became incautious, resulting in delays when experiments had to be repeated. In general, students lacked sufficient laboratory experience and required intense mentoring to successfully complete even basic procedures. Although exhausting, overcoming these trials made the experience extremely rewarding for both students and mentors.

**Economic Analysis**

As part of the research project, four second-year interns took a top-down approach to analyzing the economic feasibility of biofuels on a southern Illinois farm. Interns prepared for this economic analysis by reading journal papers on evaluation topics and specific sections from micro and macroeconomics textbooks selected by associate professor Mark Jornd (Business Department). Initially, the interns were given complete autonomy with regard to the project direction. However, students had difficulty understanding the complexity of the sources and could not independently figure out an approach.

As an alternative, the students were led through a “what if” discussion to determine the macroeconomic impacts of biofuels on the economy. This Socratic approach helped the students understand the complex nature of the economy and the opportunity costs associated with alternative fuels. It also helped them reason with economic facts as opposed to their personal opinions. The interns developed a list of pros and cons along with questions to investigate. Given their limited experience conducting research, lessons were devised on proper sources and research methods. As a result, the students developed stronger research skills and a better sense of how to identify appropriate sources.
After the research phase, the interns drafted a rough outline of the macroeconomic topics they considered most important. The work was divided among the cohort to help manage the workload. This decision created a new problem. It became clear that a few students were carrying the entire team, causing resentment and disagreement. Faculty advisors organized a discussion of work ethics and the importance of completing tasks on time. Interns voiced their concerns and came to agreement about workflow and proper communication channels. The interns worked on their outline for several weeks until it satisfied the requirements of the grant and was eventually completed and reviewed.

The outline was used to develop a research direction for the group and, eventually, a research report. The research report included macro (qualitative) and micro (quantitative) issues. As with the lab skills portion of the project, the students’ lack of previous relevant course work (in this case, business or economics courses) made this work much more challenging. Students found the process difficult and went through many iterations but a finished report was finally presented to the supervisory staff.

The students’ understanding and writing ability evolved over the course of this project. The economic reports are a testament to their growth and development. The interns all worked very hard and felt proud of their final product.

Although difficult to quantify, involvement in the program seems to have made a significant impact in the educational careers of interns and students. Three of the interns were awarded significant transfer scholarships and one biology student was accepted into a competitive professional program. When contacted after the program’s completion, many students indicated that their involvement impacted their choice of a future career toward the areas of agriculture, science or engineering.

This project was funded by the USDA New Era Rural Technology Competitive Grants Program: National Institute of Food and Agriculture CFDA 10.314 USDA-NIFA-RTP-002694.
In the mid-1990s, the black bear (*Ursus americanus*) population in the Alleghany region of New York experienced a dramatic increase. As a result, bears moved northward and took up residence in areas that had only seen occasional wandering bears before. Humans hold a fascination for black bears, and media coverage of this range expansion and the associated human-bear encounters was heavy. The New York State Department of Environmental Conservation is the agency responsible for managing wildlife populations in New York. Local staff of the department began a two-pronged approach to address the situation. The first part was launching a small-scale research project to gather baseline data on the bears, while the second was to conduct public presentations to educate humans on how to behave in bear country.

Finger Lakes Community College was uniquely poised to assist in these endeavors. Two of the four counties in our service area were in the heart of the expanded black bear range. In addition, the college has a large Department of Environmental Conservation and Horticulture, which is among the largest producers of associates degrees in the nation (ranked second highest in 2013 according to *Community College Week*). Thus the state’s environmental agency was very receptive to a partnership that would allow it to work with the college; from the college’s perspective, the partnership would allow us to provide a truly unique opportunity for students and a service to our community. We ultimately created a sequence of courses in black bear management (the only ones New York State) and agreed to both long- and short-term commitments to the project.

Since then, the black bear range has continued to expand and the college’s partnership with the state agency has allowed us to respond to new needs as they arise. The college’s students and staff play a valuable role in the management of black bears in our region. Although our journey was not
always smooth, I believe it can serve as a model for other institutions seeking to meet the needs of the larger community.

Why Bears?
There are other environmental needs in our community that could be studied, so why did we select this one over others? First, it was an issue of great interest to my students. The black bear story was capturing their imagination in a way that other environmental issues did not. In addition, the general public was interested as evidenced by the stories in our local print, radio, television, and electronic media. I could easily convince students that we were doing important work when our activities were being reported in the news. There is a wide range of human perceptions of bears, providing ample teachable moments for me as the instructor. And although human injury from black bears is rare, it is a real possibility. Much more common is the destruction of property (including crops), making management of the bear population important on an economic and personal level. Finally, the message we heard from state officials was simple: We would do more if we had more resources.

Initial Steps: Low-Hanging Fruit
As our partnership first developed, we offered assistance in areas that complemented our academic strengths. That meant creation of an educational presentation on bears and the purchase of telemetry equipment.

The creation of our original presentation “Bears in our Backyard” was a collaborative effort among the wildlife-focused faculty and staff in our Department of Environmental Conservation. Five of us got together and created a storyboard for what we felt it would be important for community members to know about black bears. Each person then selected a section or two to research and create. Our goal was to personalize this presentation to our specific service area. Thus it included sections on the history of bears in the Finger Lakes region through the examination of historic journals, as well as material on current black bear management efforts by the college and the state agency using photographs and preliminary data, and maps that showed sightings of black bears by local residents.

Once the PowerPoint presentation was completed, our faculty and staff offered it at various venues throughout the community. Demand for speakers on the topic was great and our willingness to help complimented the efforts by the state staff members who could not accommodate all the requests for their presentation on the subject. As I enjoy public speaking, I presented our show over three dozen times at public schools, libraries, nature centers, other colleges, and at our own field station. Once an estimated 400 people showed up at a venue with 180 seats! People waited, and I offered a second presentation. We knew we were meeting a need in the community.
The second focus of our part of the partnership was assisting in the procurement of technical equipment—radio telemetry gear. The state agency wanted a better understanding of the home range of the bears in our area, as well as how that range changed seasonally. A common way to explore these questions is through radio telemetry. In the case of black bears, individual bears are fitted with collars that emit signals that can be detected remotely. The simplest of these devices emits a very specific VHF (very high frequency) wave that is detected remotely with a receiver. More complicated (and expensive) models contain GPS (global positioning system) technology in which positional data is stored in the collar and downloaded once the collar is retrieved. Regardless of the sophistication of the technology, this necessitates the capture and handling of wild bears.

The questions posed by the state agency regarding bears’ range and seasonal variations are major research questions and to answer them completely would require a large investment of time and money. We did not have enough resources to create a full research project of the scope desired, but we could provide enough assistance to provide useful information. We could collar several bears and gather what information we could in order to gain a better understanding of their movements.

Our department qualifies for equipment purchases through the federal Carl D. Perkins Vocational and Technical Act (aimed at preparing students for vocational-technical positions that do not require a baccalaureate degree). We offered to allocate money from that source to purchase radio telemetry gear (collars and receivers), keeping in mind that we would be involving students in the data-collection efforts. Before any purchases were made, we made it clear to state officials that the “Perkins money” came with strings attached. Simply put, we would be using the equipment to properly train students with future employment in mind. Therefore, we asked for a greater role in the actual handling of the wild black bears, as well as the continued monitoring of them after the collars were attached.

In hindsight, this may have been the single most important aspect of our partnership. The only money we could provide for equipment purchase had to be used extensively with students. This was not an artificial condition we created; it was required by the source of the money. We presented a comprehensive plan to our state partners in which our students would not just be observers as bears were fitted with collars, but also would be actual assistants in the process. The state officials agreed.

**Growth: The Partnership Evolves**

The original commitment of funds described above occurred more than a decade ago. Since then, some staff members at both the college and the state agency have changed, as have some of the needs regarding the black bear situation in our area. Maintaining a good working relationship with
the state partner requires time. I strive for ways to continue to make my students and me useful each and every spring field season.

Black bears are typically captured for collaring in one of two ways. First, a person may stumble upon a hibernating bear and report the location to the state agency. Cubs make a lot of noise when they are present and even when bears are quiet, lone bears cannot escape detection by the keen noses of dogs. Second, bears can be safely captured in large live traps when they exhibit a predictable pattern (say, consecutive nights at a residence’s bird feeders). Either way, once a bear is collared, it is expected that it will be recaptured during the next den season to assess its health and replace its collar for one with fresh batteries. It is at these “den visits” that my students conduct most of their work.

It is difficult to describe in a few words a typical bear den visit. My students and I do not participate in the actual chemical immobilization, but we do participate in just about everything else. We carry gear, record data, collect biometric information such as temperature, heart and respiration rates, and CRT (capillary refill time) to monitor the bear’s reaction to the immobilizing drugs. Bears are weighed to assess overall health. When cubs are present, they are not immobilized and must be kept warm. We use fleece bags and tuck them into our jackets. Additionally, we assist in answering questions from any other members of the public who are present at the site, including landowners and their guests. My students must be trained in all of these procedures before going into the field.

Several years into the partnership, state environmental officials came to us and asked if we would be willing to help answer two questions: When were the cubs born and what is a “typical” bear den like in the Finger Lakes? Both questions were proposed as long-term research projects, and they continue as of this writing. Students reviewed the literature, drafted protocols, and created data sheets. Now we had an additional purpose at each den visit (measuring den characteristics) and at dens with cubs, we were even busier.

**Closing the Loop: Meeting the Needs of Students and the Community**

My department initially offered a course in which undergraduates conducted the research fieldwork described above under a “Special Projects” heading, rather than going through the entire curriculum-review process because faculty were unsure how long we would be able to offer the research/fieldwork opportunity or how popular it would be. After years of watching the course and fieldwork efforts evolve and guiding them along as the department chair, I wrote proposals for two courses: Black Bear Management I and II. Black Bear Management I, a one-credit course would only be offered in the fall semester and serve as a prerequisite for Black Bear Management II (a two-credit course offered only in the spring). This was in response...
to the problem we had with the timing of the den visits. New York state officials conduct den visits in February and early March. A course in the fall semester would not work because it would end before the visits to the bear dens, and a course exclusive to the spring semester did not allow for enough instruction before students were to perform in the field. Splitting a single course into two smaller ones was our solution to adapting the academic calendar to an animal’s biology.

Another challenge I faced during the formal curriculum-review process was the size of the course. I capped enrollment at 12 students in each of the two management courses. There is precedent at our institution for capping field-based courses at 14, but I explained that our partner was concerned about the number of people at each den visit. Our administration agreed to the lower cap.

As mentioned above, students must take the first course in the sequence in order to take the second, but I had to decide if there would be any prerequisites for the first course. Each year, our students represent college and the state agency at den visits and in the media. In addition, I was envisioning the black bear courses would require a large amount of higher-level academic engagement. In the end, I chose as a prerequisite a freshmen-level wildlife identification course that is required of all majors in our department. In this way, more students are eligible to take the course. I offer the bear management courses during the wildly unpopular time slot of Friday afternoons. The course was popular but often students seemed to be focused only on the potential for a den visit and the hands-on work, without being willing to give an honest effort to the rest of the class. I felt that the Friday afternoon slot would eliminate some of the less-motivated students and, at our institution at least, it would not interfere with many other course offerings.

To complement the long-term research based on the den visits, black bear management students engage in a short-term study throughout the academic year. For students to learn the most from an undergraduate research experience, they need to be involved in the steps of a project from start to finish. Our research questions are ongoing and have established protocols that cannot be redefined year after year. So a smaller project that students can accomplish in ten months has the advantage of allowing them to experience all the steps in research. We maintain the same rigor as one would in a larger research project, but the amount of data we collect is much smaller. In recent years, we have investigated students’ knowledge and attitudes regarding bears through a survey, ground markings of black bears along trails, bear bites on utility poles, and the use of camera traps to study behavior.

My students come to the black bear management courses with a range of abilities in reading and mathematics, but everyone reads peer-reviewed journal articles. We read two articles in the fall—one on characteristics of
bear dens and the other on collecting biometric data to determine cub ages. Both inform our work in the spring semester, and I take the time to work through the methods and results of each paper until everyone has a working knowledge. One year, a student asked for clarification on one of the cub measurements that I had never thought to ask before. She asked, “Do we measure the ear to end of the cartilage or the end of the hair?” When I told her I didn’t know, she asked how we should proceed. I told her to contact the author. She asked me very sincerely: “Can I do that?” I asked her: “Why not?” We had our answer by the next class period (cartilage).

We cannot accomplish all that we do without devoting a large amount of time to our work. The major pushback I receive from students in Black Bear Management I and II is that they only receive three credits for the amount of work they do. Yet there is always a waiting list for the course sequence. I believe the students are willing to devote the extra time partly because they see the value in what we are doing and partly because they see that I too am devoting extra time to the course as well. Although these courses add only three credits to my teaching load each year, they do require a large amount of effort on my part including multiple den visits, annual meetings with our partner, constant review of the literature each year as the topic of our short-term project changes, attention to long-term data management, assisting students with oral and poster presentations at local, regional, and national events, and responding to requests for information from the media and educational groups. However, just like the waiting list of students, there is no shortage of other instructors ready to take my place and reap the rewards of teaching this enjoyable and meaningful sequence of courses.
Participation in a 2012 workshop organized by the National Council of Instructional Administration (NCIA) and the Council for Undergraduate Research (CUR) led a four-person team from Orange County Community College (SUNY Orange) to design an action plan for promoting undergraduate research—leading to the campus’s first Achievements in Research and Scholarship (SOARS) Conference just a year later.

The action plan developed by the SUNY Orange team, which consisted of the vice president for academic affairs and three faculty members, set several goals for increasing student engagement in research at the college. The goals included recruiting faculty and students to serve on an undergraduate research task force, as well as establishing a format for an internal conference to encourage research across campus. The inclusion of the vice president (author Perfetti) on the workshop team was essential in garnering administrative support for a conference from the institution’s board of trustees, the president, and other vice presidents.

Faculty participation was accomplished through multiple presentations by the team members to faculty, including at a joint divisional meeting and a workshop at the college’s Center for Teaching and Learning. These efforts yielded a group of faculty representing a cross-section of departments on campus. A student member was appointed based upon prior participation in the mid-Atlantic regional Beacon Conference, which showcases research accomplishments at two-year institutions. The newly formed undergraduate research task force was assigned the following charge: The SUNY Orange Undergraduate Research Task Force is being established to
promote an atmosphere of student engagement in research and scholarly activities that encourages faculty-student collaboration, celebrates student achievement, and establishes a campus-wide culture of student innovation. This will be accomplished via:

- Defining undergraduate student research for the College
- Identifying undergraduate research opportunities already available to students
- Establishing a communication and education outreach plan regarding undergraduate student research
- Designing and organizing a campus-wide conference highlighting student research and scholarship

Meeting monthly for the next year, the task force undertook the challenge of establishing a definition of research broad enough to include the various disciplines on campus, while simultaneously upholding the academic standards consistent with the institution’s mission and values. Lengthy discussion yielded agreement on the following adaptation of the CUR definition: *Undergraduate research is an inquiry or investigation conducted by an undergraduate in collaboration with a faculty mentor that makes an original, intellectual or creative contribution to the discipline.* The broad nature of this definition represented a deliberate effort to be inclusive, with the ultimate goal of increasing research opportunities for students in science, technology, engineering, and mathematics (STEM) fields, as well as in all other disciplines represented on campus. In the context of this broad definition, the group then sought to establish a campus-wide conference to highlight student research and scholarship as a means of encouraging student engagement in research activities.

Designing the SOARS conference was a formidable undertaking that involved collaboration and consideration of a range of perspectives to capture and convey the intended inclusive and multi-disciplinary nature of the event. The task force considered the range of submissions that could be eligible for presentation at the conference, given the many disciplines represented on campus, as well as the desire to preserve the integrity of a research conference. This challenge was resolved through the delineation of three categories of submissions: research paper, research poster, and creative research project. The group then established submission guidelines for each of the three categories. The research poster and the creative research project were required to be accompanied by a four- to five-page written paper explaining the theoretical or conceptual foundation that inspired the creative project or poster. Permission was obtained from the Beacon Conference Steering Committee to model the SOARS submission guidelines after the Beacon guidelines. This was done with the long-term goal of increasing SUNY Orange students’ participation in the
Beacon Conference. The consistency between Beacon and SOARS submission guidelines allows students to enter their work in both conferences, thus providing multiple opportunities for students to collaborate with a faculty mentor, increase their proficiency in research and public presentation, and enhance their resumes.

Consistent with the goal of increasing undergraduate research through the celebration of student research and scholarly achievements, the SOARS conference is non-competitive. All students who submit work that meets the guidelines for research papers, research posters, or creative research projects are invited to present at the conference. Further, submissions and presentations are not judged or ranked relative to the work of others. However, in the interest of providing feedback to students to help them improve their work, each submission is evaluated by one or two volunteer faculty readers who complete a rubric created by the task force. The rubrics are returned to the students and their faculty mentors before the conference so that students and mentors can take the readers’ feedback into account when preparing to present at the conference. In acknowledgment of their achievement, each student receives a certificate of participation at the end of the conference signed by the vice president of academic affairs and the president.

In establishing the timeline for the conference, the task force took into consideration the goals of encouraging student research, providing students with feedback, and ultimately increasing students’ participation in the regional Beacon Conference. Submissions are due December 15th each year, allowing students to submit work from the previous spring semester, summer session, or the current fall semester. The task force then assigns each paper to one or two volunteer faculty readers, who have until February 7th to complete and return the reader rubric. By February 15th all feedback is returned to students and their mentors. Given the desire to increase participation in the regional Beacon conference, and considering that the Beacon submission deadline is March 1st every year, students who submit their work to the conference can use the feedback they receive by February 15th to revise their papers and submit their research to the Beacon Conference as well. The SOARS conference takes place each year in March.

Having defined research for the institution and established inclusive submission guidelines as well as a timeline, the task force initiated promotion of the conference through creating a SOARS website. Later a QR (quick response) code (a machine-readable barcode) was created for inclusion on written materials to direct smart phone users to this website. Further, the task force devised an outreach plan to focus attention on undergraduate research while simultaneously promoting the conference. This included reaching out to faculty to identify classes that already incorporated research, and then enlisting those faculty members to serve as
mentors and encourage student participation in the conference. Additional promotion efforts included announcements at faculty general-assembly meetings, updates via the college’s e-mail newsletter, and strategic placement of display banners at both campuses of SUNY Orange. Further, in collaboration with an instructor of visual communications, an advanced class was assigned the task of designing posters for display at both campuses. Task force members also went to individual department meetings to discuss conference details, answer questions, solicit volunteer faculty readers, and motivate faculty to encourage their students to participate in the conference. These promotional efforts were met with favorable feedback from faculty who hoped to serve as mentors, as well as those who volunteered to serve as readers. The promotional efforts for student research and the conference itself required funding. The college wanted to obtain external funding, and a grant from the Warwick Savings Foundation ultimately was obtained.

The first annual conference took place in March 2013 and was attended by 50 people, including families of presenters, mentors, faculty readers, as well as other faculty, staff, and administrators. Members of the student body served as ushers to help attendees unfamiliar with the campus. Students from a photography class were enlisted to take photos. The college’s videographer filmed the presentations. Twenty-one students submitted their work, and nine of them ultimately presented their research. Six presented research papers (in the disciplines of biology, English, and Asian history), and three presented research posters (in the disciplines of biology and English). Students had 15 minutes to present their research papers, followed by a question-and-answer session. During the 45-minute poster session, student presenters answered questions regarding their research as attendees circulated at the conference site. The event began with a breakfast reception, followed by a welcome from the vice president of academic affairs. Presentations began at 9:15 a.m. and concluded at noon with the awarding of certificates of participation to the presenters.

At the conclusion of the conference, evaluation forms were collected from student participants, faculty mentors, faculty readers, and the audience. All the student participants said they obtained information about the conference from a faculty member, indicating the crucial role played by faculty members. Students were asked to rate certain aspects of their experience on a scale of 1 to 4 (with 1 meaning strongly disagree and 4 meaning strongly agree). They rated the utility of faculty reader feedback at 4. One student commented that faculty readers “provided me with valuable, unbiased feedback which helped me write a clearer paper.” Students strongly agreed that participation in the conference would enhance their resume and portfolio. One student commented, “It is an excellent program and other colleges will be very impressed to see I did a ... paper and presented it.”
Based on survey results, faculty mentors also learned about the conference from fellow faculty members. Mentors were asked to rate certain aspects of their experience on the same scale of 1 to 4, and they either agreed or strongly agreed with the statement, “The conference was a valuable experience for the student I mentored.” One faculty mentor commented on a student presenter: “She came up from WRT030 [developmental writing] and was never a confident writer. When she was presenting, I saw her so confident and sure of herself. Her writing also improved because of our close work on her paper.” When mentors were asked to provide feedback about the experience, one noted, “It’s exciting for me to see a student so passionate about a project, and it’s valuable for the students to participate in this kind of project.”

Several mentors and prospective mentors informally suggested delination of mentor responsibilities. Faculty readers’ survey responses revealed that they generally volunteered after learning about the conference from a fellow faculty member, again reinforcing the value of promoting participation among faculty members. One reader who attended the conference commented, “I was very impressed with the set up at the Spring 2013 event.” Several readers did recommend that more detailed instructions be provided for future readers in addition to the rubric supplied. Survey responses from other attendees unanimously complimented the organization and professional nature of the conference. Many noted the importance of being able to interact with the students, both during the formal question-and-answer periods as well as informally during breaks. In sum, the feedback revealed universal support for the event from student participants, faculty mentors, faculty readers, and the audience, all of whom underscored the benefits students derive from such an opportunity.

Following the conference, task force members considered all feedback in combination with their own observations and agreed to make certain improvements for the 2014 conference. To increase student participation, the task force planned to increase promotion to both faculty and students, for example, adding video and photos from the 2013 conference to the conference website. In addition, testimonials from both faculty and student presenters have been added to the website so that prospective mentors and participants can benefit from first-hand perspectives on the advantages of participation. The task force will continue its promotion to colleagues at college-assembly meetings and individual department meetings. The student task force member has volunteered to visit clubs and classes on campus to promote the advantages of participation directly to their peers. Further, task force members will staff a table the college’s annual Student Life Day to disseminate information about the conference. In response to faculty requests for delineation of mentor, as well as reader, responsibilities, both reader and mentor guidelines were added to the website.
In preparation for the second SOARS conference, announcements were made at the college’s assembly meetings and reminders sent via the college’s e-mail newsletter. Task force members began promoting the conference at department meetings across campus, and the student representative to the task force began promoting participation to student groups and classes. The goal for the second conference was to double the number of student participants.

The academic-affairs staff at SUNY Orange is proud of having successfully taken the SOARS conference from concept to reality in one year. A key factor allowing this was the opportunity to reflect and develop an action plan with the guidance of presenters at the NCIA/CUR workshop. Moving forward, SUNY Orange plans to promote conference participation as a mechanism to foster further STEM-related research on campus, while maintaining the all-inclusive nature of the conference by simultaneously encouraging student research in all disciplines across campus.
Dissemination
Chapter Fourteen

SATURN Journal: A Model for Integrating Research into the Undergraduate Curriculum

James Remsen Jr., Louis Roccanova, Davorin Dujmovic, Padma Seshadri, and Hector Sepulveda

Success in modern science is not just based on recollection of knowledge but on inference and critical thinking—indeed developing competent leaders in any field requires the inclusion of critical thinking in our pedagogy. Teaching students how to engage in processes of inquiry, such as the scientific method, is essential. The amount of information in the scientific disciplines, particularly the life sciences, is growing at ever-increasing rates, and the ability to learn how to navigate this information is becoming increasingly important. A professional cannot rely on previously learned knowledge, but rather will have to rely on the acquired skill of learning how to learn and to discover.

Introductory science classes contain students with a very wide range of previous educational preparation. Thus, it is a challenge to design each lesson so that students with and without an extensive background can have a worthwhile learning experience and develop a deep understanding of the scientific discipline.

Traditionally, community colleges have not been considered research institutions. They were—and still are—teaching institutions at which students may obtain a start on their college education more affordably than at many four-year institutions. Due to multiple factors, including faculty resistance, resource allocations, administrative priorities, cultural norms, the demands of student employment, family responsibilities, and commuting to class, the pursuit of potentially time-consuming research projects is often divorced from the traditional two-year experience. In addition, community college faculty may have their own obstacles to overcome. With a heavy teaching load, finding the time to support inquiry-based learning may
seem impossible. Building space is devoted to teaching laboratories, not research laboratories. Budgets are restrictive even in a good fiscal climate, and thus equipment is hard to obtain.

The American Association for the Advancement of Science, in conference proceedings edited by Brewer and Smith (2011), recommends that undergraduates receive research experience during their freshman and sophomore years. The data from most standard science laboratory exercises is discarded at the completion of a course. However, new data produced by research embedded into an undergraduate course can be worth disseminating beyond the campus. This approach to pedagogy engages the interest of students through giving them the experience of contributing their own findings to a growing pool of knowledge.

At the Michael J. Grant Campus of Suffolk County Community College (SCCC, a member of the State University of New York), we have implemented the concept of embedded research and developed an initiative that serves to teach concepts and practices of scholarly peer-reviewed writing. This was done by establishing an online journal for publication of student work.

**Early Integration of Research Experience**

Initial scientific research on the Grant Campus was part of a student service-learning project, in which 72 American elm trees were planted to compare resistance to Dutch elm disease among the Princeton, New Harmony, and Jefferson Cultivars. The height and condition of these trees have been recorded by students and faculty each semester for approximately the last three years. Embedding research into our courses and creating the *Science and Technology Undergraduate Research Notes (SATURN) Journal* achieved a major step forward in March 2012 when several of us attended a Council on Undergraduate Research workshop funded by a National Science Foundation grant. At this workshop, “Tapping the Potential of All Students: Undergraduate Research for Community Colleges,” we planned the initiatives we now are implementing to incorporate research goals and objectives into our SCCC science courses.

As part of these initiatives, author Roccanova added an investigative component to a very basic laboratory exercise in taxonomy. The exercise, included in a Principles of Biology course aimed at non-majors, employs dichotomous keys to classify organisms according to the kingdoms to which they have been traditionally assigned. It was hypothesized that if students could master this basic scientific skill, then perhaps they could use it to gather new data that could be analyzed.

Students in the biology course were asked to bring to class specimens (leaves, twigs, etc.) of each tree found on the property where they reside. They also measured the circumference of the trunk of each tree at its base.
During the laboratory period, they identified the species of each tree using dichotomous keys. They collaborated in groups of up to six students, and developed hypotheses to be tested based on the locations of the property where the trees were found, the distribution of species, the sizes of the trees, and their numbers in a particular location.

One advantage of such an inquiry was that it could be done at an extremely minimal cost. Initially, inexpensive and simple dichotomous keys to common trees were downloaded from the Internet or purchased at a low cost ($4.95 per book). Subsequently, more comprehensive field guides to trees were obtained using funds from an “Excellence in Teaching” grant from the Office of the Executive Dean. Integration of the activity into existing laboratory periods was facilitated by the fact that there was usually time during class that was spent waiting for results of other experiments, during which the botanical samples collected by the students could be analyzed. Also, since a taxonomy exercise was required in the curriculum, this exercise expanded on already-existing course content and did not compete for class time by introducing totally new concepts.

Of course, collecting and analyzing data is only part of the academic process. In order to take student involvement in research to the next step, it was necessary to teach students how academic researchers disseminate the information they have gathered. The process of peer review and publication is inherent in such dissemination. Indeed, the primary measure of success in research is whether or not an investigator has attained publication in the peer-reviewed literature.

As our initiative grew, questions developed as to how we could enhance our students’ learning experiences. What if, as part of students’ research projects, they not only experienced peer review, but also had access to a venue designed specifically to disseminate the results of their work, in a manner similar to standard peer-reviewed outlets? What if, instead of simply turning in a revised paper to the instructor for a grade and/or extra credit, the finished products of students’ research could actually be released online for anyone to examine, thus providing new data and analysis to the scientific community at large?

Our students now have exactly those opportunities, in the form of the online SATURN Journal.

Establishing a Peer-reviewed Student Publication

Strategic planning and creation of the journal were handled by three of the authors—Professors Roccanova and Dujmovic and Associate Dean Sepulveda. Sepulveda agreed to contribute the funds needed for an Internet domain to establish and maintain the journal, thus avoiding having to negotiate the restrictive policies, meetings, and buy-in otherwise required to start such a journal. Roccanova serves as editor in chief and Dujmovic as managing
editor; ultimately additional faculty members, some from other institutions, were added to the editorial board based on their specific disciplines. It was hoped that these editorial-board members would solicit work from their students for possible publication, and also serve as reviewers for papers in their fields, including student papers from other colleges and universities.

The name of the journal is the acronym of the full title noted above: *Science and Technology Undergraduate Research Notes (SATURN) Journal,* accessible at www.saturnjournal.org. It serves as both an educational and research tool. The basic methodology used thus far, to teach students the process of peer review and scholarly publication, was pioneered in our Principles of Biology course. Manuscripts are submitted to the instructor, who acts as a peer reviewer and, as necessary, recommends changes to improve the quality. Students who make the necessary revisions and whose manuscripts are subsequently accepted for the journal receive an A on the manuscript and are given extra course credit for completing revision and publication. Participation in the exercise is not a required part of the course, but the extra credit for performing the research serves as an initial incentive, and many groups of students have subsequently become intellectually engaged once they begin a project and come to enjoy the experience.

More than 90 students published material in the first three biannual volumes of the journal. Some of those students have compared their findings to those of student investigators who previously published in the *SATURN Journal.* This has resulted in student citations of other students’ previously published work, just as any academic researcher would acknowledge the contributions of prior investigators in the field.

To date, most of the students who have contributed to the journal have worked on the previously mentioned studies of tree distribution on Long Island. By having students across multiple semesters work on related projects, the journal can serve as a repository of a significant amount of data on this subject. As the number of papers completed by students grows, they may serve as a source of information for faculty-driven publications either in biology and ecology or on the use of integrated research as a pedagogical tool in the undergraduate classroom.

Examples of some of the studies undertaken by students thus far include the following:

1. Many groups of students have compared the tree species found in North Shore communities of Long Island to those on the South Shore or compared those species found in their place of residence to those in other villages. Other comparative studies have examined tree distribution on eastern versus western Long Island, conifers versus deciduous trees, and so forth. Several papers contained in the first two volumes of the journal are of this type.
2. One group of mathematics students (Contreni, Qiao and Sparacino 2013) undertook a study that determined the proportion of invasive trees recorded by previous groups of student investigators whose work was published in the journal. The proportion of invasive coniferous as well as deciduous trees was determined. This work included statistical analysis of the data and represented an example of how the database being accumulated by our students may be used in the future.

We are now in the process of embedding similar research projects, with an eye on publication in SATURN Journal, into biology courses for science majors. This includes sections of the majors-level general biology and microbiology courses. Students in the latter (Falcon, Muter, Saintelia and Weinmuller 2013; Rooney and Sheridan 2013) have published their findings from experiments in which the antimicrobial properties of spices have been tested.

**Challenges, Successes, and the Future**

While many community college faculty members have engaged students in research, the establishment of an online journal specifically to receive the results of these projects, and as a means of illustrating the peer-review process to students, is an essential next step in developing a national science pedagogy. However, the journal is in its infancy, and it presents the opportunity not only for continued enhancement of SCCC courses, but also opportunities to further elevate the journal’s reputation and content.

The challenges of finding the needed time, funds, and other resources remain. As we attempt to solicit student research from additional courses, we have discovered that it can be difficult to get some students to take the initial step toward completing even a small research project. Some of these students do not initially realize the value of writing an article and having it published in an online journal. Ironically, some science majors only concentrate on test scores to obtain the competitive grades they feel are key to admission to medical or other professional schools. One of our present goals is to make students more aware of the positive impression that publishing research results can have on their applications to such programs.

We already have success stories connected to this approach. One of Roccanova’s students, who began his study of biology in the introductory course for non-majors, completed his associate’s and bachelor’s degrees in biology and returned to campus to assist students in subsequent sections of the same course. He has now been accepted into medical school. In 2013 two of author Remsen’s students, who were among the co-authors on a published manuscript (Lee, Cruz, Coiscou and Y-Rabbani 2013), received admission to highly competitive summer research programs at our
four-year sister institution, Stony Brook University. We have other goals for SATURN *Journal*:

1. We hope to see additional fields of research represented in the journal, by having additional faculty members direct course-related research in their own areas of interest. We realize that in some cases this may require additional equipment and/or funding. These requirements are currently being investigated and pursued.

2. We would like to see faculty at other institutions join with us in this venture. We are particularly interested in corresponding with faculty who may have difficulty finding an outlet for small, student-driven research and want to encourage them to publish their students’ work in the journal. We envision the possibility of such faculty serving on a peer-review board at their respective institutions to review the quality of their students’ work before submission.

In summary, our greatest hope for the journal is that it not remain just an illustrative exercise for SCCC students, but rather become a genuine repository for the results of similar efforts at other institutions, whether they be community colleges, four-year institutions, or universities. If all science students could collect and disseminate new data from research exercises embedded in their coursework, science pedagogy would reflect true scientific practice, and large amounts of new data would become available to the scientific community.

**References**


Queensborough Community College (QCC) is an open-admission, Hispanic-serving institution in the City University of New York (CUNY) system whose biology faculty members are trying to engage their students in research. Due to heavy faculty teaching loads, however, a huge bulk of the research work happens during the summer months. We have been organizing small, informal research meetings with fellow faculty and summer research students once a week over the summer months for the last five years. Since then, more faculty members in the department have become engaged in research on campus and have received various types of grants. In 2013 three other biology faculty members involved in on-campus summer research joined us and our students in the Summer Journal Club. The faculty involved in this effort came to strongly believe that this club is a very positive experience for students and has a long-term impact on the students’ academic futures.

As is the case with many community colleges, a majority of QCC’s students come from racial or ethnic minority groups, and they typically also are low-income, first-generation college students and/or U. S citizens, and unprepared for college—let alone research. Close to 60 percent of the students are women. Enrollment in the associate’s degree in liberal arts and sciences has increased by almost 49 percent since fall 2003, largely as a result of increased outreach efforts and a variety of grant-funded research opportunities that attract and retain students in various campus programs. The faculty members in the journal club all have received grant support either from federal or CUNY programs that allowed them to support research students during the summer.

The structure of the 2013 Summer Journal Club was kept simple and incorporated presentation of students laboratory work to the general
definition of Journal Clubs: “A group of individuals that meet to discuss and critique research that appears in professional journals”. Each faculty member presented a brief background description of her research followed by students presenting the details of their own experiments and data analysis. Students select projects that are closely related to the faculty research interest and are encouraged to think on their own. Mentors selected original papers related to their group research and helped their students present the paper to the rest of the group.

Challenges

QCC is dedicated to academic excellence and quality in teaching and learning. It also promotes research on pedagogy and supports scholarly accomplishments and professional advancement among its faculty members. These are challenging times, however, and expectations for faculty research have risen at the same time that higher education is facing demands for increased public accountability. At QCC, faculty members are expected not only to engage in research-related scholarly activities but also to involve students in these activities in order to be tenured and promoted. Throughout higher education, there is a general agreement that strengthening the teaching-research approach will benefit students, faculty and institutions (Osborn 2009).

Research indicates that students will learn better if they can relate their learning to actual research (Seymour 2004), faculty will be more efficient if they can integrate their primary professional responsibilities, and universities will benefit if the public perceives they are complying with their educational missions. The major challenge for faculty is to figure out how best to approach research-related activities, and, in our experience, community college faculty in particular face major challenges, such as:

- Heavy faculty teaching loads. CUNY community college faculty have to teach a total of 27 contact hours a year, divided into two semesters in spring and fall.
- Little to no release time. Due to heavy teaching loads, obtaining release time is usually a struggle.
- No start-up funding. There is no start-up research budget for a faculty member. Each is expected to partner with senior colleges or come up with creative ways to start research projects until he or she can get individual grant funding.
- Lack of research facilities on campus. At QCC, some equipment accumulated from various sources over the years is being shared by several faculty members. However, little or no updating of equipment has occurred in spite of the growing number of faculty becoming involved in disciplinary research.
Unprepared students. Since QCC is an open-admissions college with no entrance examination, most students are not academically prepared to start research projects. They require basic background training to start such projects. Most students are not aware of research possibilities on campus and lack career goals; they are not sure what scientists do.

Students’ limited timeframes. Students are on campus from one to three years, which poses problems for projects’ continuity. Often by the time they are recruited into a research lab and trained, students are ready to leave. Also, most of them work full time or part time, and spending time on research is not a priority for them.

Addressing the Challenges

Since it is nearly impossible to change the requirements for faculty teaching loads, one has to find time to work around them. If possible, try to arrange teaching schedules so that one or two days are free every week to do research-related activities. Sometimes it is also possible to find time during the teaching days to follow up on experiments and answer questions for students.

If grant funding allows for it, negotiate some release time with the department chair. All new CUNY faculty members receive 24 contact hours of release time over the course of the first five years to engage in research-related activities. This time can be used wisely to establish a project.

Collaborate with faculty from a senior college to gain access to equipment as well as projects. This can also help projects move along at a faster pace. Along with a colleague, author Trujillo has established collaborations with faculty members at Hunter College and City College, both part of the CUNY system.

If possible, start an academic program that can help obtain much-needed equipment in order to do research. Author Gadura started a biotechnology degree program and was able to outfit a modern molecular biology lab with the funds from New York State Department of Education Perkins Grant. All the new equipment is used not only to teach but also to engage students in research when no classes are being taught in the room.

Apply for both intramural and extramural grants. The faculty involved with the Summer Journal Club are recipients of Professional Staff Congress-CUNY awards, CUNY collaborative, and National Science Foundation Research Undergraduate
Institutions grants, which provide enough seed money to start projects.

- Slowly build a core facility in the department. This is where faculty members need to become creative and pool their limited resources to share equipment.
- Devote as much time as possible during summer months to doing solid research and collecting most of the necessary data, which can be hard to do during the semester.
- Colleagues engaged in research on campus need to spend time once a week to formally discuss their research experiences, as well as to informally share ideas and/or resolve any issues that might have come up. This can help create a positive environment and foster creativity.
- Faculty members need to work together to recruit students from their classes for research projects, given that most students are unprepared for college, let alone scientific projects. Some students working on projects may be volunteers, unpaid or paid depending on faculty grants, while some could be formally registered for a research internship course and receive credit for doing research.
- Employ the institution’s formal resources for training in ethical conduct of research to teach students the prevailing ethical guidelines; this is valuable in formalizing the research process.
- Find ways, such as a journal club, to give students a formal structure in which to conduct research and begin thinking like a scientist.

The Summer Journal Club

The organizers created a folder in Google Drive where faculty-selected research papers related to each faculty mentor’s own research were uploaded. A detailed guideline for presenting papers also was placed online to help students in their presentations, and a schedule of presentations was included. Meetings were Wednesdays during lunch hours. Students working in different labs could interact with each other as well as with faculty members. Each faculty member and student was expected to bring a small dish to share with others, giving a social dimension to the meetings. This club provided a unique opportunity for both faculty and students to share their research experiences in an informal setting as well as allowing discussion of foundational research papers.

The results of an anonymous survey conducted at the end of the summer indicated that students were highly satisfied with the experience (Table 1). Students reported they felt they had made tremendous gains in their
### Table 1. Student-perceived gains as measured by end-of-summer survey.

<table>
<thead>
<tr>
<th></th>
<th>No change</th>
<th>Small change</th>
<th>Moderate change</th>
<th>Large change</th>
<th>Very large change</th>
</tr>
</thead>
<tbody>
<tr>
<td>I feel that I have become better able to think independently and formulate my own ideas.</td>
<td></td>
<td></td>
<td>22%</td>
<td>33%</td>
<td>44%</td>
</tr>
<tr>
<td>I feel that I have become more intrinsically motivated to learn.</td>
<td></td>
<td></td>
<td>22%</td>
<td>33%</td>
<td>44%</td>
</tr>
<tr>
<td>Clarification of a career path</td>
<td>0</td>
<td>11%</td>
<td>11%</td>
<td>22%</td>
<td>56%</td>
</tr>
<tr>
<td>Skill in the interpretation of results</td>
<td></td>
<td></td>
<td>33%</td>
<td>67%</td>
<td></td>
</tr>
<tr>
<td>Readiness for more demanding research</td>
<td></td>
<td></td>
<td>44%</td>
<td>56%</td>
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<tr>
<td>Ability to analyze data</td>
<td></td>
<td></td>
<td>11%</td>
<td>11%</td>
<td>78%</td>
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<tr>
<td>Learning ethical conduct in your field</td>
<td></td>
<td></td>
<td>33%</td>
<td>67%</td>
<td></td>
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<tr>
<td>Learning laboratory techniques</td>
<td></td>
<td></td>
<td>11%</td>
<td>89%</td>
<td>1</td>
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<tr>
<td>Skill in how to give an effective oral presentation</td>
<td>22%</td>
<td>11%</td>
<td>67%</td>
<td></td>
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</tr>
<tr>
<td>Self-confidence</td>
<td>22%</td>
<td></td>
<td>78%</td>
<td></td>
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<tr>
<td>Understanding of how scientists think</td>
<td>22%</td>
<td></td>
<td>78%</td>
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<tr>
<td>Learning to work independently</td>
<td></td>
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<td>11%</td>
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<tr>
<td>Becoming part of a learning community</td>
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scientific skills, research ethics, oral-presentation techniques, and self-confidence. Most of them think they are ready to take on the challenges of senior colleges as well. The summer club gave students an opportunity to interact with faculty members besides their own mentors. They were able to share their lab experiences and stories, good or bad, so that they did not feel as though they were working in isolation. It also allowed our more advanced students to give advice to the new recruits.

Through this venue students were forced to come together and look at how the scientific process works, not just for their project but for others as well; they learned about the larger scientific picture and the scope of other projects. The results of the survey showed that students felt comfortable asking questions and making presentations.

Lessons Learned

We have learned several lessons about conducting research with students in the resource-strapped community college environment. The most important is—don’t give up! Among the others:

- It is crucial that you find like-minded faculty to work with, to help set a positive tone and work environment.
- It might be painfully slow at times, but learn to find and pool resources such as space and equipment.
- Find projects that require minimal equipment to begin with and slowly build a core facility for everyone to share.
- Once you have enough people involved, give research meetings a formal structure to move things along at a professional pace.
- Find ways to show students the benefits of joining research projects. It is hard to get started with the first student, but word-of-mouth from students and faculty alike eventually may lead to students lining up to get involved in a research project.
- Help students understand that the skills they acquire in labs are fully transferable to other lab settings and will strengthen their resumes and professional-school applications.
- Invite alumni back to talk to and encourage new students.
- Recognize that student-to-student bonds last even after graduation.
- The skills students acquire while doing summer research help speed up experiments in the fall and spring semesters and better prepare students to make conference presentations.
- The faculty member’s time invested in student research can pay off in several ways—for example, tenure, promotions, publications, and future grant applications and awards.
References


Increasing Retention, Graduation Through the Queensborough Bridge STEP Program

Nidhi Gadura, Paul Marchese, Paris Svoronos

The Queensborough Bridge STEP (Science, Technology, Engineering and Mathematics Talent Expansion Program) involves a consortium consisting of Queensborough Community College (QCC), Queens College (QC), and Brookhaven National Laboratory (BNL). The funds awarded by the National Science Foundation have helped create a dramatic increase in the enrollment, retention, and graduation of students in STEM (science, technology, engineering, and mathematics) disciplines by incorporating high-impact activities in the early stages of their college education. One of the most significant components of this effort is the research experience that usually begins during the students’ first year and extend throughout their undergraduate careers.

Faculty, mostly in chemistry and biology, but also in physics and engineering, mentor students in a wide variety of actual research projects that are scientifically significant, but still within the students’ capabilities. In addition, more than a dozen students every year secure internships with New York City’s Division of Environmental Protection (NYC—DEP) and the U.S. Food and Drug Administration (FDA) in Jamaica, NY, as well as engaging in summer experiences at various sites through the National Science Foundation’s Research Experiences for Undergraduates (REU) program. Currently about 60 students each year make multiple presentations regarding their research at professional conferences, including local, regional, and national meetings of the American Chemical Society. They have won numerous awards at conferences of such groups as the Metropolitan Association of College and University Biologists (MACUB) and the Annual Biomedical Research Conference for Minority Students (ABRCMS). Since 2002 more than 18 peer-reviewed articles written or co-authored by QCC students have been published. Upon transfer from the community college,
Increasing Retention, Graduation Through the Queensborough Bridge STEP Program

Students continue their research involvement with faculty at their four-year colleges, and several students are currently enrolled in graduate chemistry, biochemistry, and engineering programs. Students’ initial fears about their abilities as researchers are quickly eclipsed by the self-confidence they gain after making their first oral research presentation, usually at the QCC Annual Honors Conference.

Humble Beginnings

Queensborough Community College’s first-ever research student in the chemistry department was a female with a high-school equivalency certificate who conducted research under the mentorship of faculty members Paris Svoronos and Sasan Karimi in 2000. Her findings were first presented orally at the annual Undergraduate Research Symposium of the American Chemical Society (ACS)-New York and subsequently in poster form at the national ACS meeting in Washington, D.C. This effort was supported by the college’s administration, led by a new president.

The effort was repeated the next year with four students, who also made presentations at the New York ACS’s annual Undergraduate Research Symposium; an additional eight students followed suit in 2002. The number of students conducting research at QCC mushroomed as more chemistry faculty, both full time and adjuncts, as well as college lab technicians, became involved. Since 2003, QCC has had the most student presentations of any community college at the ACS-NY undergraduate symposium. The students have also made poster presentations at other regional and national ACS meetings (Svoronos 2010).

In 2007, with the guidance of QCC’s Office of Sponsored Programs under the directorship of Christina Johnson, a National Science Foundation STEP grant was awarded to Queensborough’s chemistry and biology departments, the same departments at Queens College, and the Brookhaven National Laboratory. More details of the project are available on the project’s website at http://www.qcc.cuny.edu/chemistry/STEP_Grant.html. The goal of the project, entitled “Queensborough Bridge,” was to increase STEM enrollment and graduation rates by involving students in research and summer internship opportunities, group tutoring, and seminars featuring guest scientists.

Queensborough Strategies for Undergraduate Research

Create a biotechnology program. Nidhi Gadura joined the college at the inception of the grant and has added an extra dimension to undergraduate research by mentoring an increasing number of students in biology projects. Her work in articulating her biotechnology program with that of York College of the City University of New York has provided an important specific major for science students to pursue upon graduation from
Queensborough Community College. Establishing this program gave Gadura an opportunity to seek funding for equipment and to start the biotechnology lab. The lab space is used for teaching and doubles as a research lab when no classes are scheduled.

Gadura started by mentoring one or two students a semester, and currently has four or five students conducting various research projects in the lab every semester. This undergraduate research was initially supported under a grant from the National Institutes of Health’s RIMS (Research Initiative Management System) and then with support from the NSF STEP, as well as an NIH BioPREP grant. QCC biotechnology students have presented at numerous conferences and have won at least 13 student research awards.

Encourage more faculty to engage in research. As students learned about the program and the potential benefit to their careers, it became easier to recruit them into research projects. Within only a few years, faculty no longer had to actively look for students; instead they came looking for research opportunities. As a result, we now have a waiting list of students who want to participate. This growth has required that more faculty members become involved in the program to mentor students. Fortunately, during the growth of the research efforts, the college also was going through a growth phase and was hiring many new faculty. The chemistry department faculty went from five members in 2001 to the current 12, while the biology department grew by 10 faculty during the same period.

All new mentors have earned their doctorates, and all are required to conduct research and publish in order to attain tenure and promotion. Some of the faculty had reservations about research with first- and second-year undergraduates, but these perceptions changed after the success of the initial research projects. With the additional faculty, the program was able to grow beyond the initial cohort of students. Faculty could benefit from the additional help with their research projects, while students gained valuable experience and credentials for their careers by creating more appealing resumes. Establishing two transfer programs in the chemistry department (one in forensics in conjunction with John Jay College and another in pharmaceutical sciences in conjunction with York College) and systematic expansion of the faculty and programs has led to a tripling of enrollment in chemistry classes since 2001. In addition, the institutionalization of the honors program has allowed faculty to be more selective when recruiting first-year students. The Honors Program at Queensborough is an academic program that provides an enriched classroom and overall intellectual experience to students who have demonstrated high academic achievement. Through course sections offered to honors students, specially arranged independent studies, research and challenging projects allow these honors scholars have an opportunity to expand their knowledge in areas of particular interest. In addition,
participation in professional conferences provides them the opportunity to
distinguish themselves among their peers, and to make an acknowledged
contribution to the intellectual and cultural life of QCC. Such students may
register in these courses after the completion of a minimum 9 college credits
and a GPA of at least 3.0 and in many cases selected by either GPA or faculty
recommendation. Incoming students with a strong high school background
can take special permission to take honors courses as well. This gives faculty
the opportunity to work with the same students for at least four semesters.
Experienced second-year students serve as mentors to the incoming fresh-
man both in research and courses. Graduation with a minimum of 12 credits
and a minimum GPA of 3.40 guarantees an Honors certificate. All completed
honors courses are labeled as such in the student’s transcript.

By 2013 the STEP program had chemistry research projects under
way in many disciplines, including projects in micro-scale physical con-
stant calculations, laser-led refractive index measurements, nano-chemistry
reactions (polymerization, reduction), ionic liquid syntheses, natural prod-
uct syntheses, antioxidant determinations in food products, heavy metal
quantification using x-ray fluorescence, and various synthetic procedures
that include silanes and phosphonates, as well complex natural products.
Currently, between 35 and 40 students are involved annually in chemistry
research under the college’s STEP grant, and their findings have led to at
least 18 peer-reviewed journal publications that bear their names. Students
who participate in these research experiences are also more likely to per-
form better in subsequent science classes and have much higher graduation
rates than other students (Table 1). These results are consistent with other
undergraduate research experiences (Lopatto 2004; Seymour et al. 2004).

Build core facilities. Instrumentation was an initial concern among faculty
reluctant to undertake mentoring student researchers. At the beginning, col-
laborations with nearby institutions helped, but this was not always feasible
because of commuting and scheduling conflicts among mentors and students.
Faculty members were innovative in their research, however, and developed
experiments that did not require sophisticated equipment. Fortunately, as
the culture of the college changed and research became more important, the
chairs of the chemistry and biology departments were able to obtain valu-
able equipment for research using various external grants. The chemistry
department established the college’s first undergraduate research lab in 2007
and a second one in 2012 through external funding. The biology depart-
ment established a 900-square foot biotechnology lab, plus a well-equipped
core facility that is shared by several student and faculty researchers. Although
research equipment is still a concern, the facilities at Queensborough are bet-
ter than those at many four-year institutions in our area.

Provide tutoring. Soon after the NSF released the funds for the STEP
grant, a systematic series of tutorials was established in the chemistry
Approximately fifteen students from the honors program were selected to conduct weekly two-hour group tutorials for 10 to 12 weeks for their peers in any chemistry class offered at the college. For many of the student tutors English was their second language, and this experience was a unique opportunity to increase their fluency in the language. Naturally, this was difficult in the beginning, but as the tutors interacted with their peers, the students receiving tutoring benefitted because they felt more comfortable asking their questions of a fellow classmate. This interaction led to the creation of a strong student cohort in which collaboration rather than competition reigns.

Since most of the tutors were also involved in research, their tutoring experience helped increase their self-confidence and the oral presentation

### Table 1. NSF STEP graduation and transfer data from QCC students involved in chemistry and biology research.

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<tr>
<th>Biology Research Students 2007 - 2010</th>
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<td>Graduates up to 2012</td>
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<td>7%</td>
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<table>
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<th>Chemistry Research Students 2007 - 2010</th>
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skills required at professional conferences. The improvement of their communication skills also helped them in other honors classes where oral presentations were embedded in the curriculum. Finally, the tutoring experience helped the tutors in interviews for job, scholarships, and admission to other institutions upon graduation from Queensborough (Topping 1996).

Organize research seminars. The final component of the Queensborough Bridge project was to create a series of science seminars for student participants. The students were asked to attend and then submit written summaries of the talks, supplemented with readings from articles and other references provided by the speakers. At the beginning, students’ summaries showed little comprehension of the scientific material. Gradually an improvement was seen not only in their understanding of the scientific concepts, but also in their writing skills. Starting in 2013 the chemistry department is hosting the monthly American Chemical Society-Long Island section seminars, which makes the mandatory students’ attendance at the seminars more convenient. The invited speakers have included professors from four-year institutions of CUNY and the State University of New York, as well as from private universities (St. John’s, Hofstra, Adelphi, Columbia, and New York Universities). A comparable lecture series was implemented in the biology department as part of the STEM Research Club.

Future Work

As a result of the success of the Queensborough Bridge project and other undergraduate research experiences in other departments, during the spring semester of 2013 the college decided to institutionalize and fund undergraduate research as a high-impact pedagogical activity (Kuh 2008). A faculty inquiry group was given responsibility for coordinating undergraduate research at the college. The committee was to define undergraduate research, create a plan for scale-up, develop learning outcomes and an assessment plan, and implement professional development for faculty interested in adopting undergraduate research. All students who conduct research at the college must also follow the CUNY Responsible Conduct for Research (RCR) policies (http://www.cuny.edu/research/compliance), and the committee was charged with ensuring that all students involved in undergraduate research do so.

Currently, more than a hundred students are involved in research each year at Queensborough Community College. Several models are currently being implemented by various departments. These include for-credit research classes, research experiences (or modules) within existing classes, and extracurricular research (such as a summer research experience). The research has been funded through various grants and funding sources, such NASA, NIH, and NSF, including two recent NSF-REU grants. As a result of these disparate efforts, there is much variability in what students receive
for their participation in the research. It is expected that the faculty inquiry group will try to address this concern.

Undergraduate research at Queensborough Community College has grown significantly since the first student participated thirteen years ago. There have been obstacles to overcome along the way, but as a result of faculty efforts students are now more engaged in STEM classes and perform better; enrollment in STEM programs and classes has also increased. As the college scales-up undergraduate research and more students become involved in various projects, we expect these results to continue.

References


Most institutions of higher education are embracing undergraduate research as a vital part of the curriculum. Undergraduate research is an effective tool for measuring and enhancing critical-thinking skills, and serves as a bridge to higher-level undergraduate course work and graduate school. Many large research universities have experienced researchers and a stable of graduate students ready and willing to help with research projects, but often seasoned researchers are scarce at community colleges. Redlands Community College (RCC), in El Reno, Oklahoma, has emerged as a leader in undergraduate research after discovering that retired researchers from neighboring institutions are great partners in coordinating full-scale undergraduate research experiences for students.

Here we describe the development of one segment (agriculture) of the undergraduate research program at RCC. The college had developed a working relationship with a nearby federal agricultural research laboratory where students were employed as technical assistants. Some students used portions of the data they collected there for personal research projects. This established a conduit for students to gain research experience and for the laboratory to cultivate potential employees since all federal research facilities have a goal of increasing the diversity of their pool of job applicants. The links between RCC and the federal research laboratory eventually evolved into a well-funded research program as the laboratory’s staff became linked with Redlands’ research program and provided advice on experimental design and statistical analysis.

Several elements were involved—procuring grants to fund a quality research program, recruiting senior research scientists upon their retirement from the federal laboratory, filling adjunct teaching positions, and using adjuncts to mentor students conducting grant-funded research. Redlands was able to gain decades of research experience at minimal expense, and
the research scientists have an opportunity to continue to be involved with research, but with a reduced time commitment.

History of UR at Redlands

Undergraduate research is embedded across RCC’s agriculture curriculum. Students are introduced to research principles in a required class, AGRI 2133: Computers in Agriculture. Since most of the students are familiar with basic computer concepts, the course is used to teach applied computer principles within a mock research project based on published research found in professional journals. Guided by the instructor, students develop a mock research project in the course, including an abstract, a concept map, a literature review, and a Powerpoint presentation. On RCC Research Day, students present research posters of mock research projects to the student body and faculty. Students with outstanding posters are selected to go to the annual Great Plains Honors Symposium.

The next semester, most of the agriculture students enroll in a course called AGRI 2223: Explorations in Agricultural Research. These students work with William Phillips, a retired U.S. Department of Agriculture (USDA) scientist, on conducting, evaluating, publishing, and presenting research projects in a variety of settings. The course objectives include learning what is and is not research, how and why research is conducted, learning to use Internet access to professional journals and research organizations’ databases to find answers to questions, analyzing raw data, and then presenting at a scientific meeting the summarized data as a poster that describes an experiment and the findings. RCC students have presented their research at the State Capitol Higher Education Research Day, the Oklahoma Academy of Science Annual Technical Meeting, and Oklahoma Research Day (attended by students, graduate students, and faculty from Oklahoma’s two- and four-year colleges) where more than 600 posters are presented.

Redlands’ Research Partnerships

Redlands Community College sits across a river from the United States Department of Agriculture’s Grazinglands Research Laboratory, part of the Agricultural Research Service. The service is the research arm of the USDA and operates 100 research facilities nationwide. The mission of Grazinglands is to develop and deliver improved technologies, management strategies, and planning tools for evaluating and managing economic and environmental risks, opportunities, and tradeoffs for integrated crop, forage, and livestock systems in various climate, energy, and market conditions. The laboratory has partnered with RCC since 1976, providing introductory classes, tours of laboratories, physical facilities for some of the RCC animals used in teaching, and employment opportunities for students during the academic year and during the summer when some paid internships are available. The lab
is affiliated with many of the four-year land-grant universities in the region, which provide further undergraduate and graduate opportunities. Proximity is one of the reasons for a rich partnership with the lab, but having former RCC students on the staff at the research facility and having the lab jointly sponsor college events helps keep the lines of communication open.

The community college’s partnership with the lab has taken many forms. The equine program at RCC has provided horses for lab personnel to use to move beef cattle among the pastures on the 6,700 acre laboratory facility. RCC provided the greenhouse space and personnel that the USDA needed for a two-year project. Similarly, when RCC needed pasture to maintain a cow herd for teaching, the USDA lab was able to provide the necessary pasture. The Grazinglands Research Laboratory also participated with RCC in programs that helped minority students gain valuable experience in a research environment and kept them on track to stay in college and earn a four-year degree.

Student employment at the lab and lab personnel teaching at RCC are two components of the partnership that reap major rewards. For example, in the summer of 2012, three of our students were employed by the USDA lab. One was working directly on research that he planned to present and publish, and two other students were employed as research interns—one was a current RCC student and one was a former RCC student. The former RCC student had enrolled in a four-year college after receiving her associate’s degree, but was selected for a lab internship because of her connection with the RCC research staff and a former USDA staff member. USDA research staff members also deliver guest lectures at RCC and give tours and demonstrations of new technology to students in RCC laboratory classes.

The Benefits of Retired Scientists

There are several advantages to working with retired research scientists. They bring a wealth of research experience, tend to be very motivated to work with students, and appreciate the lack of pressure to “publish or perish” even though they often have vast experience with obtaining grants and outside funding. They are very appreciative of the lack of bureaucracy in their day-to-day work as adjunct faculty: We have found that they are willing to help with grant writing and co-publishing, but they also appreciate the fact that there is someone in administration to handle the inevitable difficulties. Often compensation is one of the lowest priorities for retired researchers, so identifying their particular motivation is key to successfully retaining them as faculty.

Advantages for the institution are abundant as well. The presence of sage researchers is a boon for the community college culture. Many established community college faculty may not have ties to research communities
and welcome the renewed interest in research subjects. Being exposed to research inspires other faculty to begin thinking about developing undergraduate research projects in their own courses. Retired researchers mentor community college faculty, and their presence can increase the legitimacy of the community college in the academic world.

Having research experience is a great advantage for community college students as they transfer to four-year institutions. They have already rubbed elbows with researchers, have presented research at conferences, and often have published in research journals. Community college students are often initially intimidated by research and researchers, and often the low-key, retired faculty member is less intimidating for both traditional and non-traditional students alike. The age difference between most students and retirees also allows for rich intergenerational experiences.

Disadvantages include a lack of funding to properly compensate adjunct faculty for their time. Some researchers lack experience with at-risk student populations and may have limited hours to commit to the college. Most retired researchers have trained master’s and PhD students and may have unrealistic expectations of freshmen’s abilities. It also is imperative to work with retired faculty to ensure that retirement payments from their previous institutions are not compromised by the adjunct pay they receive. Working around adjuncts’ travel and vacation plans is also important because often retired researchers place priority on their freedom to travel with their spouses and to visit grandchildren. Pairing the retired scientist with a new adjunct faculty member who can “fill in” for them often is an excellent way to cover the classroom, and it also allows the retirees to mentor their new counterpart. At RCC, administrators often work with the retired faculty member on teaching and grant writing to allow for minimum hassle and optimum use of their expertise.

William Phillips is an example of a retired research scientist who has had considerable impact and success as an RCC adjunct. He joined RCC in 2011 after retiring from the Grazinglands lab after 34 years of service. He was familiar with the RCC faculty, having served as an adjunct guest lecturer, giving tours to students in introductory animal-science classes, co-sponsoring agricultural events with RCC, and supervising RCC students working at Grazinglands. As retirement approached, he contacted the president of RCC to explore the possibilities of using his experience and talents there since he and his wife, also a retired educator, planned to continue to live in the El Reno area. Phillips came from a family involved in education, and like others of his generation, he felt an obligation to pay back society for the investment it had made in his education. As an undergraduate, he received some financial support from the U.S. Army through the ROTC program at Middle Tennessee State University, and as a graduate student he was awarded a National Defense Fellowship that supported him through his
master's and PhD programs at Virginia Tech. As Baby Boomers like Phillips approach retirement, they can be recruited to fill adjunct positions at community colleges as instructors and mentors of undergraduate researchers as a way of repaying society for investing in their careers.

**Possible Research Projects**

Research projects at two-year institutions are very similar to master’s projects in terms of time and student turnover, but master’s students are ready to go at the beginning of the first semester and have some experience and technical background. Freshmen at RCC who are interested in doing research cannot be identified until the second semester of their freshman year, which means that the research projects they undertake must be of short duration and consist of gathering data that require limited processing other than statistical analysis. Also, master’s programs in agriculture have a support system of laboratories capable of quantitative and qualitative research, experimental animals and plots, technical support, and a research culture—all of which may not be present at many two-year colleges.

In order to fill the pipeline with research data, RCC initially used unpublished data from pilot trials or one-year studies that Phillips brought with him from his USDA position (giving credit to USDA with co-authorships or acknowledgements in all subsequent publications). Thus some of the first students used data already collected, while others collected data for next year’s students.

At the beginning of Phillips’ involvement in the research program, RCC was able to use NSF grant funds to acquire a Ceptometer, which measures photosynthetic light radiation. Students have used the device to measure the amount of photosynthetic light at the top of a plant’s canopy and then under the canopy. The amount of light being captured by the plant’s canopy could be estimated (above-canopy measurement minus the below-canopy measurement) and used as an indirect, non-destructive measurement of the size of the canopy. Students have used the tool to measure the plant canopy developed by different varieties of wine grapes, the impact of cultural management on the growth and development of wine and table grapes, and the response of vegetables to water-resource management. Since this instrument is used in production agriculture to monitor crop development, its use gives RCC students additional experiences that are transferable to the work place. Students also work with some survey data used to develop regressions or correlations between abiotic, physical factors, and crop yields. They have the opportunity to build simple models of production systems.

**Funding Opportunities**

Four-year institutions with graduate programs have an advantage over the two-year colleges in competing for research funding. They typically have
some hard dollars that can be used for in-kind contributions to the costs of research projects, and they may have a whole staff dedicated to writing grants. However, there are niches in which two-year colleges can be competitive, mainly because two-year colleges have much lower overhead than the four-year institutions. All of the salary dollars requested on grants are in direct support of the research directed toward the “product, because we cover the administrative costs entailed in the projects. Four-year colleges are pricing themselves out of the market for relatively smaller grants, and some are seeing the advantages of collaborating with two-year colleges, given that some federal programs reserve funds for two-colleges. The following are three examples of funding sources used at RCC:

1. Oklahoma’s state government has established a Viticulture and Enology Fund that is financed by a tax on wine and wine products purchased in Oklahoma. Grant applications are taken annually for projects that will stimulate the growth of Oklahoma’s grape and wine industry. In 2012, RCC applied for and was awarded more than $146,000 to fund four research projects that dealt with grape and wine production. Topics included selection of grape varieties, spacing of vines within rows, altering the chemical composition of grape juice to produce better wines, and the impact of the environment on grape production.

2. Through the Oklahoma Department of Agriculture, the college applied for and was awarded USDA funding for two projects (amounting to approximately $16,000). The USDA grant programs were targeted toward specialty crops and required in-kind contributions from applicants, but RCC used equipment and personnel funded by previous grants as its in-kind contribution. Two-year colleges do not have the hard dollars for in-kind contributions to support research and therefore must be creative in identifying in-kind contributions by leveraging existing equipment and salaries.

3. Two- and four-year institutions that are usually outside the main funding streams for research can band together and apply for NSF grants. Redlands Community College has provided leadership and oversight in the establishment of the Viticulture and Enology Science and Technology Alliance (VESTA), which was ultimately funded by NSF. Missouri State is the principal investigating institution on the grant and RCC is a subcontractor, with a portion of the grant coming to RCC for research. This grant is funded for five years, which adds stability to our research program.
Having to compete for funding annually is a challenge and requires a change in mindset for retired researchers from organizations like USDA that had hard dollars to fund their programs. At our level, project goals and design must fit within a short timetable and must be doable with young, inexperienced, part-time (less than 20 hours per week) assistance.

Conclusion

Building a research component within the RCC culture was and is a challenge. Using retired research scientists as catalysts, however, is an approach that RCC has used effectively within its financial constraints. Administrators from the top down must be on board with the need to infuse research into the learning process, and they must be supportive of recruiting and retaining talent that cannot be obtained through the normal instructor/educator recruitment process. State funding sources and national funding programs for two-year colleges must be identified and used as seed funds to develop a research program.

Care also should be taken not to overly invest in highly technical equipment that requires highly trained and experienced personnel to operate. Projects for two-year college students need to be concise and short or divided into phases that have clear objectives and goals accomplishable with the two-year timeframe. And very importantly, beginning students need experienced students as role models to see that they can compete in the research arena.
Recent years have witnessed a growing recognition of the importance of involvement in research to the cognitive and professional development of undergraduate students (Froyd 2008; Bransford 2000; Kuh 2008). Increased recognition is also being given to the fact that quantitative literacy must an essential outcome of college (Association of American Colleges and Universities). Nonetheless, programming to achieve such educational outcomes often appears concentrated in the physical and natural sciences. Much less emphasis has been placed on the relevance of undergraduate research for undergraduates in the behavioral and social sciences. However, this situation appears to be changing. The National Science Foundation (NSF) now recognizes psychological science as relevant among the scientific disciplines, and the American Psychological Association (2011) advises that research experiences are a basic component of a quality undergraduate education.

It was in this context that the psychology department at Inver Hills Community College opened its psychology laboratory in 2009. Undergraduates at Inver Hills now have the opportunity to engage in hands-on psychological science through the measurement of muscle responses, the tracking of eye movements, and the observation of brain waves in an introductory course in general psychology. These experiences provide opportunities for students to become motivated by the thrill of exploration, with the cognitive and practical skills they gain in the process potentially sparking greater passion for the discipline and improving students’ likelihood of transferring to a four-year institution or improving their job prospects. As such activities become increasingly central to the mission of the department, the faculty will be better able to prepare a broad range of
students to continue their academic journeys with a keener understanding of psychological science, its application to the real world, and a feel for how to engage in the scientific method.

A Brief History

A more detailed account of the history of the Inver Hills psychology laboratory can be found elsewhere (see Kaufman 2010). In brief, however, Connie Manos-Andrea and I had the good fortune in 2007 of being trained to implement classroom-based psychophysiological exercises at an NSF-sponsored workshop (Thorsheim, LaCost, and Narum 2010) led by Howard Thorsheim of St. Olaf College and Robert Gephart of Itasca Community College. The workshop focused on teaching psychological science from a “lean and lab-rich” perspective. Each workshop participant was sent home with a basic set of psychophysiology equipment and a preliminary laboratory curriculum that could be adapted to faculty interests and student needs. This laid the foundation for a potential psychology laboratory on our campus. All that remained was a need for additional equipment, dedicated space for the laboratory, and projected funding at 20 times the annual departmental budget.

I attempted to build on what I learned in the NSF-sponsored workshop by revising my general psychology syllabus to include hands-on laboratory work that complemented and extended the lectures. Over the next two years, I refined my laboratory skills through trial and error, while also soliciting feedback from students regarding the impact of the laboratory exercises on their learning. In the third year following the workshop, our dean worked with the department to direct one-time federal stimulus funding toward the formal establishment of a psychology laboratory on campus. The laboratory opened in a repurposed classroom that was cramped but nonetheless allowed for an air of excitement when students wired each other up for psychophysiological experiments as part of class. The fourth year saw the laboratory move to a larger space, one with dedicated wiring and furniture that allowed the psychology department to capitalize on our campus’s limited resources. Ironically, the psychology laboratory is now ensconced between the geology and physics laboratories—perhaps adding to our perceived credibility as scientists on campus.

A Day in the Lab

A typical day in the psychology laboratory is focused primarily on guiding students through experimental lessons in psychophysiology. Students break into groups and use Biopac hardware and software at the 10 workstations to explore the workings of the mind/body through measurements of reactions such as muscle responses, eye movements, and brain waves. Depending on the week, students might also be engaging in lessons with virtual rats
(Cengage Learning, 2005), exploring the logistics of psychometric evaluation, or even being exposed to relaxation training. All of these laboratory exercises are typically conducted within a dedicated general psychology course. This course is an adaptation of the mainstream general psychology course; the lectures remain the same, but a two-hour laboratory replaces the regular hour-long discussion seminars. The general-psychology-with-laboratory course was developed to capitalize on the relatively unique opportunities offered by the psychology laboratory. Students are required each week to think critically about their laboratory data and hypothesize why things did or did not go to plan.

Einstein is said to have observed that play is the highest form of research. This observation serves as a tacit guiding principle in the psychology laboratory. The purpose of the laboratory and its dedicated general psychology course is to acculturate undergraduates to the scientific method through hands-on learning activities. Students directly experience that the scientific method is a messy business, one characterized not by the idyllic linearity presented in their textbooks, but instead by the vagaries of mind/body dynamics. Consequently, students must learn how to ask questions and weigh the potential validity of their answers. As Thorsheim (in press) states, “scientific observations are not just any kind of observations, but rather very careful observations, made with much thought beforehand” (3). Congruent with Bowen's argument (2012), such observations are not to be made in a scholastic vacuum. The psychology laboratory therefore provides a dedicated space in which faculty can utilize their developing relationships with students to mentor scientific reasoning. Students working in the laboratory are encouraged to think deeply and learn from their failures as well as their successes.

Summary and Recommendations

Now in its fifth year, the Inver Hills psychology laboratory has become recognized as one of the numerous foci of scientific work on campus. It is an example of the good that can result when faculty can share their visions for promoting student learning and success in a manner that is readily understood and formally supportable by administrators. Nonetheless, there were challenges along the way, challenges of training, financing, and culture. First, the faculty in the psychology department required the training necessary to offer psychophysiological laboratory exercises to their students. The NSF-sponsored workshop described above introduced two instructors in the psychology department to both the technology and its implementation in the undergraduate classroom. Second, creating a psychology laboratory on campus ultimately required funding far in excess of the department’s annual budget. Although the seed equipment had been secured, founding a laboratory required purchasing additional hardware and software, securing and eventually customizing a dedicated space on campus, and ultimately
ensuring a sufficient flow of consumables to the laboratory within the budget constraints of the department.

Third, and perhaps most importantly, the culture of the psychology department had to change. Opening a psychology laboratory at a moderately sized community college required a change in how the psychology department conceptualized itself. Instead of considering its mission as one of service—providing the basic first- and second-year courses necessary or popular among the student body—the department had to open itself to the notion of becoming a home for scientific thinking on campus. Similarly, although perhaps less directly relevant, the other science departments on campus, from physics to sociology, had to adapt to the shift in apparent status of the psychology department as becoming a lab-based unit.

Nonetheless, psychological science is increasingly taking its place among the other sciences on campus. With its laboratory, the psychology department is doing its part to usher in a more-inclusive perspective on the scope of the scientific method. It is rare that students studying at a community college have access to laboratory-based experiences in the behavioral and social sciences. Yet students in their first year at Inver Hills have the opportunity to explore the workings of the mind/body through psychophysiological, learning, and psychometric exercises that expose them to the breadth and depth of psychological science at its best. It is a good time to be a student at Inver Hills Community College.

References


Studies of students attending four-year colleges have found that those who participate in undergraduate research:

- Learn a topic in depth.
- Learn to work independently, as well as in teams.
- Learn to tolerate obstacles faced in the research process.
- Develop critical-thinking and problem-solving skills.
- Develop self-confidence.
- Clarify career goals.
- Improve oral and written communication skills.

(Lopatto 2003, 2010; Russell et. al. 2007; Seymour et. al. 2004; Hunter et. al. 2007).

Participants in the CUR/NCIA workshops recognized that community college students also could attain these benefits if they had the opportunity to engage in research. In various ways, each of the programs described in this monograph employed strategies to develop these skills. The chapters demonstrate that undergraduate research enhances learning and contributes to career training. Students develop the ability to work independently and in teams and to address the challenges inherent in research, thereby developing skills in critical thinking and problem solving. The research process as a whole, as well as opportunities to disseminate findings, increase students’ self-confidence.

**Contributions to the Community College Mission**

The approaches included in this monograph underscore the continuing primacy of the instructional mission of community colleges. All students will benefit from learning the basic skills of research: observation, posing questions, developing and testing hypotheses, collecting and analyzing data, and using evidence to develop a conclusion. In addition to being incorporated into courses, some examples of undergraduate research in this volume were “optional” or grew from internships or service-learning projects. Many of
the participants in our regional conversations noted that students earning B's and C's achieved a better understanding of disciplinary content and were more enthusiastic about their studies when they participated in research. Evidence to support this observation is found within this monograph.

As place-based institutions, community colleges exist to serve the needs of their respective constituencies. Local issues can provide excellent contexts for community colleges to use to engage their students in undergraduate research. Our contributors describe their successes in collaborating with community and state agencies to address specific community needs. Through their efforts to contribute to vibrant, sustainable communities, community colleges can develop coalitions that contribute to their own institutional sustainability.

The importance of community colleges to workforce and economic development has increased during the years that CUR and NCIA have been involved in this project. Examples throughout this monograph demonstrate how undergraduate research has been the vehicle used to develop workforce skills to meet the current demands of local and regional businesses and industries. Such larger collaborations provide the opportunity to stimulate growth in emerging fields, leading to economic development and job creation.

**Benefits to Higher Education**

Community colleges have long served as an access point to higher education. Our contributors present evidence that undergraduate research has helped increase enrollment, supported efforts to increase retention, enhanced students’ completion of associate’s degrees, and encouraged transfer to baccalaureate institutions. Undergraduate research programs at community colleges can play a significant role in fueling the pipeline in science, technology, engineering, and mathematics (STEM) fields, attracting and retaining students in STEM disciplines, and encouraging continued study toward baccalaureate and graduate degrees. The contributions of community colleges are important to national efforts to increase the number of college graduates, as well as for encouraging innovation and global competiveness.

**Conclusions**

The authors included in this monograph and the more than 400 faculty members who participated in this project have clearly demonstrated that community colleges can engage students in undergraduate research. As more and more students begin their postsecondary education at community colleges, it is important for undergraduate research to become an integral part of the community college experience. For students wanting to continue their education in STEM fields, the process of transferring to a four-year
college will be easier because they will have had experiences similar to those of many students who started at a four-year college. For community college students who become K-12 teachers, the experience of undergraduate research will give them a deeper appreciation and enthusiasm for such studies, as well as the skills and experiences they need to introduce their students to research at earlier ages. And if students become technicians in a research laboratory or industry, they will have the requisite skills to contribute to the research and development necessary to advance U.S. capabilities in our globally competitive environment.

Of course, not all students will choose science as their profession, but scientific literacy is important for every citizen, and undergraduate research is one way to develop that literacy. Many of the current societal challenges, such as protecting water and air quality, understanding climate change, and the safe use of medications, require a level of scientific understanding. In addition, observation, questioning, problem-solving, and applying the rules of evidence are skills that will be useful in any profession.

**Recommendations**

The CUR/NCIA project ultimately encompassed 12 workshops across the country. The longer we were involved in this effort, the more we became convinced that the next step in increasing undergraduate research in community colleges was through curricular change. Since community college faculty tend to view undergraduate research as an add-on or complement to the teaching enterprise, continued efforts should focus primarily on the curriculum and on providing support for faculty who integrate undergraduate research into the curriculum. To that end:

- Community college administrators and faculty need to work together to integrate undergraduate research into the curriculum and seek ways to make research opportunities available to more students. Increasing numbers of students can be involved in research when it is integrated into the curriculum, particularly into general-education courses.

- Boards of trustees, university system offices, and state legislatures need to recognize that engaging students in research is a legitimate and powerful teaching strategy. They need to encourage the interests of faculty members in engaging their students in undergraduate research and support faculty efforts to integrate student research into the curriculum. In some cases, this may mean making the process for curricular change more flexible.

- Faculty unions should support faculty who provide research opportunities for their students.
> Academic departments need to examine the curriculum and determine ways in which a developmental sequence of research skills can be incorporated throughout the curriculum.
> Community colleges should provide support for research through a grants office, an institutional review board, and community outreach to locate research opportunities.
> Laboratory technicians should have access to professional-development opportunities to prepare them to assist faculty in incorporating research into laboratory courses.

References


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Robin Araniva is the science instructor at the Ocean Research College Academy (ORCA) and a biology instructor at Everett Community College in Everett, Washington. She received her master’s degree in curriculum and instruction from the University of Wisconsin and completed undergraduate double degrees in zoology and Spanish at the University of Washington. As a Teach for America alumna, Araniva’s passion for inquiry-based science is based on her own experiences of hands-on learning at the high school and college levels and graduate studies on the role of metacognition in science education.

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Nidhi Gadura, who earned her PhD from City University of New York Graduate Center in 2004, has been an assistant professor in biology department at Queensborough Community College of the City University of New York since 2007. She created an associate-of-science degree in biotechnology at Queensborough, where she teaches general biology, genetics, and biotechnology courses. She has developed curriculum to involve students in engaged-learning in her biotechnology course, which is honors and writing intensive. She also engages several undergraduates in her molecular and cell biology research lab that has led to peer reviewed publications. She is always interested in improving her teaching strategies by engaging students to do hands-on work in the lab and at the same time expanding her understanding of the pedagogy of teaching. Several of her students have gone on to win
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Mark J. Haefele is the lead faculty member for anatomy and physiology and for undergraduate research at the Community College of Denver. Having himself transferred from a community college as a junior to the University of California, Davis, he has first-hand knowledge of the importance of undergraduate research opportunities in the community college environment and their ability to transform a student’s learning.

Nancy Hensel is the president of the New American Colleges & Universities. Prior to assuming her current position, she was the Executive Officer of the Council on Undergraduate Research (CUR) from 2004 to 2011. CUR received eight National Science Foundation grants to support undergraduate research during her tenure with the organization. She also served as president of the University of Maine at Presque Isle, provost at the University of Maine at Farmington, and department chair at the University of Redlands. She received her doctorate from the University of Georgia in early childhood education, masters’ degrees in early childhood education and theatre, and a baccalaureate degree from San Francisco State University.

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Richard Jarman is currently a professor of chemistry at the College of DuPage (COD), in Glen Ellyn, Illinois. He received his DPhil in chemistry from Oxford University in 1981. From 2006 to 2011, he was campus director of the Undergraduate Research Collaborative, a project funded by the National Science Foundation (NSF) involving several community colleges in the region. He was named one of the 2013 recipients of the Award for Incorporating Sustainability into Chemistry Education, sponsored by the American Chemical Society’s Committee on Environmental Improvement for his work on the Green Fuels Depot.

Mark Jornd, associate professor of business at Rend Lake Community College in Ina, Illinois, has developed alternative methods to improve student understanding of global issues involving economics, accounting, and business issues. Concentrating on freshman and sophomore academic development, he emphasizes the importance of accurate research techniques.

Jason A. Kaufman, PhD, EdD, is an associate professor of educational leadership at Minnesota State University, Mankato and a licensed psychologist. His teaching focuses on guiding future educational leaders to utilize research methods as they pertain to their professional roles. His research focuses on the ARC of Leadership, the potential of attention, relaxation, and contemplation to facilitate leadership and leadership education. He was previously an instructor in the psychology department at Inver Hills Community College, in Inver Grove Heights, MN, where he worked to imbue psychophysiological laboratory activities into his courses.

Ardi Kveven is the founder and executive director of the Ocean Research College Academy (ORCA), an innovative early-college program for high-school students at Everett Community College in Washington. Focused on introducing students to the marine biology of the Pacific Northwest, she taught marine science and oceanography from high-school to the college
levels for fourteen years prior to developing ORCA with a grant from the Bill and Melinda Gates Foundation. Kveven views science as an active process, one that all students should have an opportunity to experience. She continues to explore powerful examples of teaching and learning in STEM disciplines, and she serves as a geosciences councilor for the Council on Undergraduate Research. Kveven earned her bachelor’s degree in biology with a marine emphasis, along with her teaching certificate, from the University of Washington. She holds a master’s degree in science education from Western Washington University and a United States Coast Guard 50 ton Master’s License.

Heidi G. Loshbaugh is dean of the Center for Math and Science at the Community College of Denver and a strong advocate of undergraduate research as a learning and discovery tool. She believes that the components and processes of research—the methods and processes, critical thinking, and interactions with boundaries of knowledge—serve students as powerful intellectual tools that are useful in many civic, personal, and professional pursuits.

Paul Marchese, professor and chair of physics department at Queensborough Community College of the City University of New York, has been involved in undergraduate research for more than twelve years under the auspices of grants from NASA and NSF. The author of numerous articles on oceanography, space weather, and science and technology education, Marchese is also involved in several initiatives to increase the number of under-represented students in STEM fields. His current research interests include studying the physics and chemical composition of Long Island Sound, and the composition of the solar wind in Long Island Sound. He also does research in STEM education and has been involved in incorporating active learning methods (including undergraduate research) into introductory science courses. He earned his PhD in earth and environmental sciences from Columbia University.

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Caroline Ragan, associate professor of biological sciences at Rend Lake Community College in Ina, Illinois, teaches anatomy and physiology as well as biology and is particularly interested in integrating laboratory techniques and research opportunities into the undergraduate classroom to promote students’ interest in STEM (science, technology, engineering, and mathematics) careers.

James Remsen, Jr., assistant professor of biology at the Michael J. Grant Campus of Suffolk County Community College (SCCC), has a background in systematics and evolutionary biology and is currently the coordinator of the full-year majors biology sequence on the campus. He maintains a professional relationship with the American Museum of Natural History, the site of his dissertation research, and is using that relationship to foster student interest in biological research. On campus, he is supporting the tree-distribution research started by Dr. Roccanova and is promoting awareness of the SATURN Journal project to the academic community.

Louis Roccanova, associate professor of biology at Suffolk County Community College in Selden, New York, created the current biological
Author Biographies

The projects have expanded to include studies of tree distribution on Long Island. He has mentored students in each effort. As editor in chief of the SATURN Journal, his goal is to use research to teach science and to use more community college courses to generate novel findings in science.

Josh Searle is an instructor in English, humanities, and political science at Everett Community College in Washington and a founding faculty member of the Ocean Research College Academy (ORCA). Previously a National Board Certified teacher in English/language arts, Searle has focused for the last eighteen years on ways to engage students of all ages in writing effectively and reading critically. At ORCA, he has also focused on disciplinary integration, portfolio assessment, and preparing undergraduates for independent research. He earned his bachelor’s degrees in English and political science at the University of Washington and his master’s in teaching at Seattle University.

Hector Sepulveda, associate dean of academic affairs at Suffolk County Community College in Selden, New York, has a background in human resources and public-health administration. He supported efforts to develop the SATURN Journal as part of his interests in affording community college students opportunities similar to those available at four-year universities. He acts as a liaison between faculty participating in undergraduate research and other members of the college administration.

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Paris Svoronos, who joined the Queensborough Community College faculty in 1981, is a full professor of chemistry and chaired the department from 2001 to 2010. He was selected as the CASE/Carnegie Foundation as the Outstanding Professor of the Year in 2003, and he is the 2014 chair-elect of the American Chemical Society-New York section. Although a synthetic organic chemist by trade he is conducting research with students microscale physical constant measurements and determination of antioxidants in beverages. He has been the principal investigator on several grants and has also published several laboratory manuals and reference books. He is co-author of a chapter in the latest (94th) edition of the CRC (Chemical Rubber
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**John J. Van Niel** is a professor of environmental conservation at Finger Lakes Community College in Canandaigua, New York. His interests lie in wildlife study, primarily of mammals and birds. Current undergraduate research projects include work with black bears, river otters, and camera traps.
The role of community colleges is undergoing a major transformation. These institutions enroll 45 percent of the nation’s undergraduates, and, as the cost of higher education continues to rise, more students are beginning their college educations at community colleges before transferring to four-year institutions. The federal and state governments, as well as business and industry, are expecting community colleges to assume an even greater role in workforce development and the knowledge economy in the future. Engaging community-college students in undergraduate research prepares them to contribute to the economic and social development of their communities and regions. With support from the National Science Foundation, faculty from more than 100 community colleges learned how to engage their students in undergraduate research, scholarship, and creative activities. The authors of this volume share their experiences in implementing undergraduate research and offer valuable strategies for making it a success in their courses and at their institutions.