CURQ Vignettes:

Additional Examples of *Undergraduate Research for All*?

Research is a Cornerstone of Nursing Practice

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Robert Hutchins, a famed American educator, once said: "The object of education is to prepare the young to educate themselves throughout their lives." This quote addresses the very heart of the question: Undergraduate research for all? In the nursing major, the answer to this query is a resounding "yes." The accrediting body for the profession of nursing states that "professional nursing practice is grounded in the translation of current evidence into practice." Thus when preparing students for practice as professional nurses, it is necessary that they understand information literacy, the research process, the protection of human subjects in the conduct of research, and the process for validating healthcare quality and safety measures.

In this major, "research for all" is not a question, but a given. Every course in the major has an outcome related to research. These course objectives build from simple to complex. In the early courses in the major, students are expected to become more critical in their analysis of sources of healthcare information. Next, they are expected not only to apply current research findings to the individual plans of care for their clients, but also to critique the status quo of the healthcare system. As they progress through the major, they are expected to complete a meta-analysis of current research findings as they analyze the evidence base for nursing skills in the acute care setting and make policy/procedure practice recommendations based on that evidence base. In addition, all students are required to complete a professional poster presentation aimed at disseminating nursing research. Thus, "doing research" is not a goal in itself, but foundational to the practice of the nursing profession. Research is not segregated as part of an "honors" program or "special topic," but integrated as a building block for competence as a nurse.

Student-Faculty Collaborative Historical Research at the University of Wisconsin-Eau Claire

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The capstone activity for history majors at the University of Wisconsin-Eau Claire encourages innovation in student-faculty collaborative research. In 1997, for their capstone students researched the historical context of a number of clauses in the 1848 state constitution and presented their findings to the Wisconsin Supreme Court. In 2004 capstone students contracted with the Chippewa Falls Museum of Science and Technology to create online exhibits based on their research. In 2009 our capstone, which guides all majors through student/faculty collaborative research, celebrated its 25th anniversary.

The program has changed over the years to reflect changes in higher education. When the requirement for a capstone project was introduced in 1984 students wrote term papers. Ten years later, the capstone required a paper based on primary sources that engaged secondary literature. In 2000, it became a three-semester sequence that introduced students to archival research as sophomores. In the senior year, they work collaboratively with other students in their seminar, along with their instructor and an additional faculty member, as they become historians, commenting on each other's research and revising it based on feedback.

Our approach in history fits well at UW-Eau Claire because we are designated by the University of Wisconsin System as a Center for Excellence in Student-Faculty Collaborative Research, with funding for such projects. Our campus library houses an Area Research Center for the Wisconsin Historical Society. Not all history majors excel at original research and writing, but they all learn from the process, and we can document that. The best students receive student-faculty collaborative research grants and are paid to conduct research over the summer. Many present papers at conferences, such as NCUR. In 2008, the capstone became central to the department's assessment plan. Our six learning outcomes are introduced and practiced in the sophomore course, and students have the opportunity to demonstrate mastery in their senior year. Students majoring in public history must interpret their capstone research in a format accessible to the public.

Undergraduate Research for All Majors in the Mathematical Sciences

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For the last seven years, all majors in mathematics and statistics at East Tennessee State University have been required to conduct undergraduate research as part of their graduation requirements. Three credits of MATH 4010, Undergraduate Research, accordingly are built into the 120-hour schedule for graduation. Four faculty members, including the author of this vignette, have "taught" the class over this period; these faculty members do take on the supervision of some students' research, but they typically assign most students taking the course to colleagues, according to the students' interests. Widespread faculty buy-in is critical if this strategy is to succeed, and we are lucky to have faculty members who have received National Science Foundation REU grants, as well as graduate student mentors who have conducted research as undergraduates at minority-serving institutions. The outcomes of MATH 4010 have been successfully assessed for three years as part of the University's Academic Quality Initiative. Student papers have appeared in refereed journals and conference proceedings, as well as on professional organizations' Web sites.

Are all math majors capable of engaging in meaningful undergraduate research? Our answer is a definite "yes," provided one allows for varying levels of activity that range from research that advances a disciplinary field to submitting a paper to a refereed

journal. The key benefit is the immense sense of ownership that students (at all levels of preparation) feel about their projects.

The Advantages and Disadvantages of Embedding Undergraduate Research into the Curriculum

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At Albright College, both traditional and non-traditional psychology students complete an independent research project. All traditional students take a "blended" statistics and research methods two-course sequence, in which they conduct a literature review, develop a research proposal, collect and analyze data, and write and present a research report. Non-traditional students in an accelerated evening program also take this blended course and then complete an independent research project in their capstone, final course.

There are several benefits to embedding research into the curriculum for all majors. First, students have the opportunity to work closely with, and be mentored by, faculty. Second, this supervision of undergraduate research is part of the faculty member's regular teaching load. Third, for traditional students, requiring this course early in the major has increased the number of students who do a subsequent research project, often as an independent study or senior thesis, and then present or publish that work. Fourth, it enables all non-traditional students to conduct research, which is typically rare for this student population. Fifth, alumni report that this experience was critical in preparing them for graduate school. Most importantly, these projects increase students' engagement in learning and improve their understanding of statistical and methodological concepts, critical and scientific thinking, and communication skills.

Despite these many benefits, there are challenges as well. The main disadvantage is the difficulty some students encounter when completing the project due to their own skill levels. Second, the workload for faculty who supervise these projects is extremely high. Third, such projects require a significant amount of resources, including faculty, student assistants, a large pool of research subjects, and access to research materials for a large number of students.

Although there are clear challenges to embedding undergraduate research in the curriculum in both traditional and non-traditional programs, we contend that the benefits of such an approach outweigh the associated costs. Evidence to support this viewpoint is derived from positive student feedback, the rewarding nature of this collaborative work for faculty, gains in student learning and post-baccalaureate outcomes for graduates. Additional information or course materials are available from the email address above.

Undergraduate Research Challenges with Non-Traditional Community College Students

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I have been successfully mentoring biology students from various programs at Queensborough Community College for almost four years. My students have won several regional and national awards at undergraduate conferences. The journey for many of them, however, is still rough. The college largely serves minority-group students who are first-generation college students from extremely diverse backgrounds. More than half of our students report having to work to support their families. While I am firmly committed to the power of research and know how it can transform students' lives, at the same time I realize that not everyone is ready for a research commitment. In my experience, given our student's economic backgrounds, it would be unfair for us to demand that they be involved in mandatory research programs. Research needs dedication and time.

When I accept a student into my molecular biology lab, I have to be sensitive and realistic about the time required to be involved in a project. I don't expect students to quit their jobs to work in the lab. If a student needs to work to pay bills, research would be the last thing on his or her mind. Therefore, my priority is to include student stipends when I write grants. I particularly look for summer research opportunities that come with stipends because I know that even a little bit of money will go a long way toward helping my students make a decision about whether they will do research over the summer or just take an odd job that will not help their career in the long run. As an educator, I know that by providing research opportunities I can help my students gradually increase their dedication to science. I have had more than twenty students graduate out of my lab in the last four years and all of them have moved on to graduate programs, reinforcing my commitment to introduce them to research.

Early Undergraduate Research at the Ocean Research College Academy

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Freshmen and sophomores enrolled in the Ocean Research College Academy at Everett Community College would not describe their undergraduate research experience as compulsory (though it is)—rather many would describe it as the most influential component of the students' entire two-year degree. Guided by the core learning outcome of active exploration and research, and encouraged by positive student evaluations, academy faculty have identified three attributes of successful undergraduate research: relevance, interdisciplinarity, and rigor.

First, student research at our academy is made relevant through projects involving monitoring of physical and biological param-

eters of water quality in a nearby estuary, a project titled State of Possession Sound (SOPS). Students are active participants in a long-term scientific research project, but this is balanced by our commitment to allow each new group of students to design their own research protocols, determining where to deploy equipment and collect samples on monthly boat-based research trips. Although all students live in the area, few have spent time on the water, but they quickly take pride in the fact that they are the only group monitoring the area monthly.

Second, work on this research program is reinforced in all courses. For example, the introductory oceanography course links SOPS data to its core content; courses in the humanities explore how Americans view nature; history emphasizes local development; and pre-calculus develops graphical analysis skills. All academy faculty members are active participants in SOPS cruises, helping students deploy equipment and collect data. Perhaps even more important, however, is an emphasis in all coursework on the use of evidence based on scientific inquiry to support central concepts studied in the classroom.

Third, academic rigor has led to increases in students' confidence in their academic abilities. This confidence is necessary for students to fully engage in the process of trial and error that is so key to successful scientific research. The nature of research emphasizes rigor, but asking students to try, fail (replicating much of the scientific endeavor), and then learn from that experience adds a level of intensity to students' work.

Students communicate their research findings to the general public and the scientific community at conferences, completing the cycle of rigorous, relevant, and interdisciplinary connections.

Outcomes in Compulsory Undergraduate Research in Calculus

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It is important to initiate the basics of undergraduate research early in the college curriculum. A primary avenue for this infusion is a gatekeeper course in each discipline that incorporates an advisor or role model for each undergraduate. At Hampton University, a private historically black institution founded in 1868, the Financially Oriented Research Calculus Experience (FORCE) is being studied to answer the question: Does model curricular instruction focused on integrating financial applications into student research projects significantly increase achievement in calculus for majors in STEM (science, technology, engineering, and mathematics) fields?

Most of the majors in such fields at Hampton are required to take one of two calculus gatekeeper courses, which provide an early indication of how successful students will be in the STEM disciplines. Several authors have attributed low African-American persistence rates in math and science to students not seeing the relevance of highly theoretical basic courses and to the lack of role models and mentors. In addition, students embarking on a college-level research project may be shy due to a lack of pre-college research experience. Our study will provide evidence about student performance when instruction moves from the traditional lecture format to an inquiry-based mode that requires students to apply calculus to financial or other real-world topics. For example, in the basic textbook, students learn equations and derivatives, but they must translate the mathematical calculations into use in a real investigation, such as the rate of natural increase or decrease of a population. African-American research mentors are key participants in the project, meeting about fifteen minutes weekly with each student in the course and identifying future collaborators.

The major goals of the study are to assess the impact of FORCE on student retention and progression in STEM courses. Will the project increase students' grades or trim course-withdrawal rates? We currently do not have sufficient data to draw conclusions, but this effort has the potential to increase real-world financial and business decision making among undergraduate STEM students.

Undergraduate Research in a Psychology/ Neuroscience Curriculum

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Participation in undergraduate research engages students in activities that promote valuable higher-order thinking skills. Implementing a program that involves students in research requires commitment on the part of the faculty and the institution. Commitments are needed in three areas: time carved out of faculty teaching loads, resources, and recognition that undergraduate research is a valued activity. In our psychology curriculum, research skills are incrementally built into the four-year program, culminating in a required two-semester senior thesis in spring of the junior year and fall of the senior year. In our sophomore-level research-methods and statistics class, students begin learning important research, writing, analytical, and programming skills by conducting their own individual experiments. These skills are augmented in two upper-division lab courses, and a number of other classes also incorporate research activities, providing experiences for majors and non-majors alike.

In addition, students anticipate our required capstone as part of the "departmental culture" that has emerged from 35 years of our program of research. They take a two-credit, all-departmental capstone course, similar to advanced research methods, and a two-credit research seminar with a faculty expert in a particular research area, with opportunities for joint collaboration across areas. In the spring semester students develop a research proposal, and in the fall students collect data and write a thesis that also serves as a portfolio of their work. Students are required to present their work in multiple venues, including an undergraduate conference. Institutional funding for capstones, travel, and research initiatives is provided through the annual departmental budget and college grants. Student-faculty collaborations resulting in presentations or publications are included in faculty reviews and recognized as an important measure of teaching efficacy.

For faculty the work is labor-intensive and providing seminar course credit for faculty members is essential, but it does offset some of the responsibility they would otherwise have for teaching advanced courses. Post-graduation placements and alumni reports testify that both students who engage in graduate study and/or join the work force immediately have been well prepared for these transitions by their extensive undergraduate research experience.

Creative Inquiry Projects: Research Opportunity for All Students

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The geology program at Clemson University in South Carolina recently instituted a six-semester, undergraduate research course sequence that requires all geology majors to participate in ongoing departmental research projects from their sophomore through their senior years. As part of a university-wide initiative on undergraduate research, termed "Creative Inquiry" at Clemson, the experience provides students both the opportunity and the necessary funding to address real local research problems in the earth sciences. Clemson is a selective, public, land-grant university with an undergraduate enrollment of approximately 17,000 students; it graduates about 10 undergraduates per year with B.S. or B.A. degrees in geology.

The research course sequence is set up to meet two goals simultaneously: (1) to give students classroom instruction about research strategies and techniques, ethical issues and stakeholder concerns, effective technical communication, and other skills ordinarily covered in a variety of general-education competency courses; and (2) to allow students to put these concepts into practice through their Creative Inquiry investigations. Many of the interdisciplinary group projects that result from the course sequence culminate in group presentations and the publication of research results. Students may choose from a variety of project options, led by different faculty mentors, many of which involve environmental monitoring within university-owned tracts of forest land. Previous projects have involved such diverse topics as geologic mapping of pegmatite dikes, a study of shark dentition, micro-geodeformation monitoring, and water resource needs in India. As they progress through the three-year course sequence, students become more deeply involved in leadership roles for their projects.

Assessment of the pilot offering of the sophomore research experience, through two Nominal Group Process focus sessions with an external evaluator, indicated that students recognized the effectiveness of these courses in fostering better inquiry, analysis, and presentation skills. Students especially liked the experience of being involved with practical applications (real world problems) in earth science and noted positive differences between their research tasks and typical classroom assignments. They did not, however, like the requirement that they present their research reflections in an e-portfolio format.

Undergraduate Physics Research at Central Washington University Michael Braunstein

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The physics department at CWU (a state-assisted, regional comprehensive masters-granting institution) has more than a decade of experience in requiring majors to complete a research project for both its bachelor of arts and bachelor of science programs. Because every student is required to complete research, the resulting projects range in complexity and not all projects fit the mold of a traditional "honors" undergraduate research option.

A critical component in the viability of our initiative is strong institutional support for undergraduate research. This support includes: university-funded small-grants programs, a science honors-thesis program with competitive funding for both students and faculty mentors, a timely (late spring) university-wide symposium in which students disseminate research in a professional environment, university co-sponsorship of a peer-reviewed undergraduate research journal, broad collegial support that values undergraduate research mentoring, and institutional recognition of mentoring undergraduate research as a portion of faculty workload. The department also has ongoing external funding for faculty and student research. In addition to individual faculty grants, physics faculty are deeply involved in an interdisciplinary National Science Foundation-funded Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP) project that transitions students into faculty-mentored research relationships.

Based on both internal and external assessments of the physics program, student feedback, and unanimous support among CWU physics faculty members, the undergraduate research requirement is recognized by the university as an important and significant strength of the department's bachelor's degree programs. In recent surveys of senior physics majors, 71 percent reported that the department prepared them "extremely well" or "very well" in attaining technical and intellectual skills, two important objectives of engaging undergraduates in research. Even so, the department currently faces a number of resource pressures on its commitment to research experiences for all majors. Enrollment in physics classes is growing even as the department is losing faculty, space, and budget resources. The physics department is employing CWU's program review and assessment processes to the fullest extent to demonstrate the value of, and the necessity for, continued investment in our universal undergraduate research program.

Introducing Scientific Practice through a Required Research-based Course

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Science Methods and Practice introduces juniors to research in the life sciences, broadening participation from the few who normally would pursue extracurricular research to include everyone in the class. I provide students data about how intertidal snails grow under different experimental conditions, and

then students formulate and test hypotheses with these data. The numerous pedagogical benefits include spending class time actively developing research skills, analyzing primary literature, conducting statistical analyses, and completing peer reviews. Students' in-class work is of high quality, and their final papers are extraordinary.

The pedagogical costs are mainly student complaints. Some students do not want to study something as esoteric as intertidal snails, so I have introduced a second research project that students complete entirely during class time. We collaborate to identify a single question, read primary literature, author and administer an anonymous survey, analyze the survey data statistically, and present the findings in posters. In the snail research, many students learn to use the literature to broaden their topic to socially relevant issues such as global climate change, making interdisciplinary connections across narrowly focused research questions. Some students complain about learning statistics even as they learn to analyze data and critically evaluate statistical conclusions. This research experience is highly structured and not as independent as extracurricular research projects can be. However, the structure is appropriate given students' diverse backgrounds: This course is required for majors in biology, environmental science, environmental studies, and science technology studies. Further, students from other disciplines can take it to satisfy distribution requirements in the natural sciences.

Another benefit to Science Methods and Practice is that the structure helps me with my own research. The course content aligns with my scholarship, and students offer new insights about my research questions. This course benefits my department because it is not as expensive as granting release time for advising independent study, nor is it as demanding on faculty as formal mentoring. In sum, this compulsory research experience is successful because it teaches students about science by having them do science, it advances the research program of an individual faculty member, and it is efficient for a department to administer.

Undergraduate Research in the Capstone Course at St. Edward's University

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St. Edward's University is a Roman Catholic institution located in Austin, Texas, serving approximately 3,600 traditional undergraduates, 860 adult learners in its New College, and 980 graduate students. All undergraduates complete the upper-division Capstone Course, except honors students, who instead produce a thesis project. While New College students also complete a Capstone project, they do so under their own distinct guidelines.

In the traditional undergraduate capstone, students hone skills they have developed throughout their college careers, including library and field research, written and oral communication, critical thinking, and moral reasoning. In their projects students research a contemporary social controversy, analyze their research, propose a solution, and undertake a civic-engagement activity. Students present their findings in 25- to 40-page papers and in oral presentations. The research component of this course is substantial, requiring students to use at least 25 authoritative sources and conduct two in-person interviews.

While there are challenges in requiring a semester-long research project of all undergraduates, the benefits are considerable. However, students must be prepared before they enter the course. Therefore, students' research skills are developed through sequenced courses in our general-education curriculum. Another challenge involves ensuring that students receive close personal attention from faculty members. Traditional capstone classes enroll 15 students, and one-on-one meetings with faculty are central to the course. Additional resource centers, such as the writing center and library, also offer support specifically tailored to capstone students' needs. A pilot program, the Mission Course Resource Center, provides tutoring specific to the capstone course. Finally, faculty development is essential and includes training sessions and mentors for new instructors, an online resource center, and an annual workshop.

The Capstone program requires significant resources, yet it is central to our institutional mission. St. Edward's University is committed to educating graduates as problem-solvers able to confront the critical issues of society and to actively seek justice and peace. These institutional outcomes demand that students be able to inform themselves through effective research and to evaluate the credibility of the information they encounter, and the Capstone project has been a successful vehicle for refining and showcasing these skills for 30 years.