COURSE-BASED UNDERGRADUATE RESEARCH

Educational Equity and High-Impact Practice

Edited by Nancy H. Hensel

Foreword by Cathy N. Davidson

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Sample Chapter

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Making a discovery, whether in the laboratory or library archives, about something that no one else in the world knows at a particular time is a heady experience for an undergraduate student. College students who have the opportunity to participate in undergraduate research can experience this thrill of discovery. They may identify a new bacterial strain, make a connection between previously separate concepts, or uncover long-forgotten archival documents that lead to a new understanding of an issue. Nearly every U.S. college and university includes undergraduate research experiences in the learning opportunities offered to students. Institutions of higher education of all types are implementing a number of creative approaches to facilitate innovation, problem-solving, and discovery. They see undergraduate research as a critical vehicle for achieving these objectives.

Benefits of Undergraduate Research

Numerous studies have indicated that undergraduate research benefits individuals, institutions, and society. Many researchers (Harrison, Dunbar, Ratmansky, Boyed, & Lopatto, 2011; Hunter, Laursen, & Seymour, 2007; Lopatto, 2003, 2010; Nagda, Gregerman, Jonides, von Hippel, & Lerner, 1998; Russell, Hancock, & McCullough, 2007; Seymour, Hunter, Laursen, & DeAntoni, 2004) have described the following benefits to students who participate in an undergraduate research experience:

- Learning a topic in depth
- Learning to work independently
• Building tolerance for obstacles faced in the research process
• Transforming the student/teacher relationship
• Developing critical thinking and problem-solving skills
• Developing self-confidence
• Clarifying career goals
• Improving oral and written skills

These benefits are in close alignment with skills identified by employers surveyed by Hart Research Associates (2013) for the Association of American Colleges & Universities.

Course-Based Research

Course-based research is the inclusion of research projects in the curriculum, and it expands research opportunities to all students. The focus of this book is course-based research in the first two years of college across all disciplines. Course-based research (including scholarship and creative activity) in the first two years typically includes the following criteria:

• Research is embedded into the course curriculum.
• All students engage in the research project.
• Students work collaboratively on the project.
• Research projects introduce students to the research methodology of the discipline.
• Outcomes of the research are unknown.
• Student outcomes of the research are communicated in some manner.

Exposing students to research in the first two years of their undergraduate education has been shown to be effective in increasing retention of students in science, technology, engineering, and math majors and careers. The National Academies of Sciences, Engineering, and Medicine (2015) found the following:

• Course-based research can provide many benefits for students from first year to senior year and also to underrepresented students.
• Many faculty members are not familiar with course-based research or are not aware of local and national models that already exist.
• Well-designed course-based research projects use many of the “best practices” identified by pedagogical research. (pp. 7–8)

Students will benefit from an early introduction to research by learning to think critically about existing knowledge, developing the ability to ask
researchable questions, exploring possible solutions, and using evidence as they analyze the results of their work. Developing these skills can and should begin in the first year of college, and all students should have the opportunity to engage in undergraduate research.

**Course-Based Research for Educational Equity**

The traditional approach to undergraduate research is for a few students, typically juniors or seniors, to work closely with a professor on a research project outside of class in the academic year or over the summer. Students who participate in summer research projects or have the opportunity to work closely with a professor in what is often called the “apprentice model” are more likely to receive the benefits of undergraduate research than students who do not have the opportunity for such experiences. Colleges and universities do not have sufficient personnel to engage every student in research using the apprentice model. The only way to provide all students with an undergraduate research experience is to embed research into the curriculum through course-based research.

Ensuring that all students have the opportunity to engage in undergraduate research is an issue of educational equity. In their report, “Separate and Unequal: How Higher Education Reinforces the Intergenerational Reproduction of White Privilege,” Carnevale and Strohl (2013) suggest that although access to higher education has improved, pedagogy has not changed to be sufficiently inclusive for first-generation and underrepresented students. The traditional approach to undergraduate research assumes that students have the time and financial resources to engage in research outside of class and in the summer. Many do not. In addition to financial constraints, Bangera and Brownell (2014) suggest that first-generation students may not be aware of potential educational and career advantages of undergraduate research. First-generation students may not understand academic culture and how to access faculty and support services. Pyles and Levy (2009) found that students at East Tennessee State University were intimidated by the idea of research. They suggest that early exposure to research can “demystify” research and help students to clarify their interests and see themselves as researchers and scholars. The inequities of the traditional approach to undergraduate research can be addressed by course-based research.

**Challenges of Course-Based Research**

Implementing course-based research is not easy. There are logistical and attitudinal challenges in developing a successful course-based research
program. Brownell and Tanner (2012) suggest that, in addition to lack of training, time, and incentives as barriers to pedagogical change, a scientist's professional identity as a researcher rather than as a teacher might be a hidden barrier. Reframing the concept of undergraduate research from the apprentice model to a concept that includes working with a whole class and seeing the acquisition of research skills as a developmental process is needed for course-based research. Adapting authentic research to the developmental needs of first-year students is a demanding endeavor. Course-based research requires significant planning time and knowledge about how students learn. It is essential to identify a project that is appropriate for the developmental level of first- and second-year students and introduces students to the research methodology of professionals in the field. Resource issues must also be considered in course-based research. Successfully replicable course-based science projects use materials that are inexpensive, readily available, and straightforward to train students to use. Social science research must be scalable in terms of numbers of subjects and complexity of the statistical design. Humanities research projects must have access to appropriate archives and other resources.

The logistical challenges of time, curricular design, and identification of projects and tools can be supported by a network of colleagues who are also implementing course-based research. Lopatto and colleagues (2012) found that a major barrier to implementing course-based research was the lack of colleague support. Course-based research is more likely to be successful when it fits within the curriculum of the department or college. Implementing course-based research across the general education program can provide a supportive campus network. A community of practice network provides support for troubleshooting, sharing information about pedagogy and use of resources, obtaining technical support, and accessing the expertise of others in the network. It also provides opportunities to share curricular ideas and pedagogy for short-term projects.

Developing Course-Based Research for the First Two Years

What would research in the first year look like? A good place to begin is to look at what aspects of the research process might be appropriate for first-year students. Some elements of research are common to all disciplines and can be integrated into first- and second-year courses. Some of these common elements, although implicitly part of research, may not be explicitly taught. Observing, questioning, making connections, and using evidence are examples of essential research and life skills that may not be explicitly part of the instructional process.
Observing

“All research starts with one crazy observation,” said Tom and Ray Magliozzi, also known as the Tappet Brothers, who hosted the National Public Radio program, Car Talk. Research does begin with observation and a sense of curiosity and asking questions. Good researchers are skillful observers. In 1854, Louis Pasteur said, “Chance favors only the prepared mind” (in Beveridge, 1957). In his 1957 book, The Art of Scientific Investigation, Beveridge describes observation as an active mental process.

John Stilgoe, Harvard professor of landscape history, takes his students on walks, encouraging them to engage in what he calls “acute observation” (Gibson, 2016) where they begin to notice things in their environment that may have been previously overlooked.

Amy Herman (2016), an expert in visual perception, takes her clients to the Metropolitan Museum of Art to increase their observation skills by looking carefully at paintings and describing what they see. She has taught doctors to become better observers of their patients and police to be more meticulous observers of crime scenes.

Success in other areas can also be enhanced by strong observation skills. Constantin Stanislavski (1989), author of several books on acting, suggested that actors should carefully observe things in daily life and then create imaginary backgrounds for what they saw. Remembering the observation can be used to bring forth the emotions of a character they might be portraying. Anne Lamott (1994), a best-selling author, talks about the importance of observation for writers. She urges writers to carry a notebook at all times and to sometimes just sit and observe what is going on around them. She suggests that it is the observation of details that gives life to fiction writing. Leonard and Rayport (1997), Harvard business professors, talk about the importance of observation in a product development strategy called empathic design. By observing how customers use and adapt products, product developers can improve their company’s products.

Jennifer Landin (2015), assistant professor of biology at North Carolina State University, incorporates drawing into her biology courses because strong observation skills are crucial for research. She suggests that drawing enhances biological knowledge and helps students to focus more carefully on the details of the species they are studying and to look at objects without bias.

The ability to focus carefully and intensively is an important skill for scholars as well as professionals in any field. Deeper learning is more likely to occur when students have “prepared minds” developed from the active mental process of acute observations.
When Stilgoe (1998) takes his students for walks, their acute observations often lead to questions. For example, one group noticed an apparent shift in iron founding from Worcester to Pittsburgh when they looked at the dates on fire hydrants, questioning, “Why did this happen?”

**Questioning**

“Research is about the audacity of the question,” according to Andrew Velkey, former director of undergraduate research at Christopher Newport University (personal communication, October 14, 2010). The ability to frame a researchable question is a fundamental skill for undergraduate research. Students often need assistance in learning how to ask good and possibly audacious questions.

Asking a question suggests that something is unknown and it is curiosity about the unknown that drives research. Students’ questions are frequently not about the unknown but rather a question that can easily be answered by a Google search. Asking probing questions that encourage analysis, speculation, and creative thinking is a skill that can be developed. Warren Berger (2014), author of *A More Beautiful Question*, defines the type of question that we want our students to ask as “an ambitious yet actionable question that can begin to shift the way we perceive or think about something—and that might act as a catalyst to bring about change” (p. 8).

Teaching students how to ask actionable questions is a valuable pedagogical objective. Matthew Bowker (2010) uses a question-centered pedagogy in his courses that he believes helps students to “understand how the answers we have come to accept are connected, contingent, and contextual, how they rely on, imply, and beg additional questions” (p. 127). Developing analytical, reflective, and open-ended questions that ask “why, what if, and how” rather than “what” encourages critical and creative thinking to challenge current assumptions or dig deeper into a topic. When framing questions, students can be encouraged to think about the hidden assumptions or bias in the question. What perspective does the question reflect? Would a woman sociologist ask the question in a different way from a man, for example? Students’ initial questions are often too broad to clearly seek information or too narrow to expand ideas and creativity. Bowker (2010) opens each class by saying that they will begin with answers and end with questions. This approach encourages students to question assumed knowledge and further develop their curiosity about a topic. The ability to frame actionable questions is a skill that will serve students well in their studies and throughout their life. The basis for good decision-making is often asking a good question. Successful actions are more likely when the decision maker can be confident that the right questions have been articulated and considered.
Connecting

Observations and questions become more useful when connections can be made among various ideas, concepts, and pieces of knowledge. The late Stephen J. Gould, a recipient of the McArthur Genius Award, attributes his success to his unique ability to see connections. In an interview with Denise Shekerjian, he said, “My talent is connectivity. I can sit down on just about any subject and think about twenty things that relate to it and they are not hokey connections. They are real connections that you can forge into essays or scientific papers” (Shekerjian, 1990, p. 5). The ability to make connections among disparate pieces of information and connect them to a new idea, concept, or product can lead to breakthrough discoveries. Professors hope that our students will make connections between what they are learning in one class to what they are learning in another class, but this does not happen for many students. While campuses intentionally integrate the curriculum to make connections, foster connectivity, and integrative thinking, professors can also encourage connectivity in their classes. Referencing what students are learning in another class can help students see how knowledge develops and is connected. A biology professor, for example, might link the discovery of the cause of malaria to the challenges in constructing the Panama Canal. Connecting course topics to outside events can add relevance to the course topics and help sustain and expand student interest. How does a trending social media story relate to the research project of the course?

Steven Johnson (2010), author of Where Good Ideas Come From, talks about the importance of connectivity in innovation. In discussing innovation, he said there are two essential elements: “First, a capacity to make new connections with as many other elements as possible. And second, a ‘randomizing’ environment that encourages collisions among all elements in the system” (p. 51). Making connections requires an open and prepared mind. Students can be encouraged to read outside their discipline, listen to new kinds of music, or see movies they wouldn’t ordinarily watch. Faculty can share how they seek new experiences and the connections they might make from those experiences. Connections are the result of acute observations, the questions that might follow, and reflection on the experience.

In addition to observing, questioning, and connecting, first- and second-year students can also learn how to use evidence in drawing conclusions and making decisions, and how to apply the research methodology of a discipline.

Use of Evidence

“What is the evidence to support your conclusion?” should become a routine question to help students understand the necessity of credible evidence in this age of misinformation and mistruths. Understanding the importance of
reliable evidence in making decisions, formulating ideas, and drawing conclusions is an important life skill. Verifying a reliable source, however, can be challenging. Developing the ability to recognize what information is credible and what information is not reliable is an important objective for course-based research and can be addressed through the inclusion of information literacy instruction in first- and second-year courses.

The Association of College and Research Libraries (ACRL) released a new framework for higher education information literacy in January 2016. The document reflects both changes in widespread availability of information and the increased role that students have in generating new knowledge through undergraduate research and scholarship. The ACRL (2016) defines information literacy as, “the set of integrated abilities encompassing the reflective discovery of information, the understanding of how information is produced and valued, and the use of information in creating new knowledge and participating ethically in communities of learning” (p. 3). Course-based research acquaints students with the process of producing and disseminating new knowledge. They also need to know how to determine the authority of new knowledge and understand that information may have different sources of authority, including expert authority but also sometimes personal experience.

A literature review is often the first step in a research project and is an excellent way to begin to develop an understanding of reliable evidence. Reading articles for their literature review allows students to see who is making a claim and to consider whether the author has the recognized expertise to make such a claim. Learning to analyze the source to determine what the authors are claiming, considering the facts the authors use to support their claim, and asking whether the facts presented are relevant to the claim are skills that can be introduced to first- and second-year students. Asking whether other evidence supports the information, whether it is new information, or whether previous information would lead to the claim the authors are making now can become routine questions for students. Students can also ask about any assumptions of the claim and whether those assumptions are based on a particular point of view or school of thinking. Engaging students in discussions of articles that pass the credibility test and those that do not will help students to internalize the skill of questioning the evidentiary basis of information. Evidence, of course, is different for different disciplines. In the sciences and social sciences, the quality of the experiment or survey can be questioned, whereas in literary analysis, the text is the source of evidence. Strategies for learning to question the evidence and make a determination of its credibility are similar, however, for all disciplines.
General Education

Incorporating research into general education courses may be the most effective way to ensure that every student has the opportunity to engage in undergraduate research and reap its benefits. The skills of observing, questioning, making connections, and using evidence can be introduced into first- and second-year courses and engage students in strategies that will enhance their learning experience throughout their college career. If research is included in introductory courses that all students take, an added advantage is that students learn a diversity of thinking skills. Learning to think in a particular discipline is a necessary skill in learning how to do research in the discipline. Learning to think across disciplines has the possibility of encouraging deeper learning and ways of knowing. History, for example, is a way of understanding people’s relationships and the interconnections of events in the past. An introductory course in history might help students to understand cause and effect in particular events, the concepts of change and continuity, and how actions and decisions affect future choices. History research involves the skills of formulating an idea, developing a plan on how to gather information, analyzing information to identify patterns, using primary sources and archival information, determining the reliability of sources, and developing a narrative based on evidence.

An introductory course in sociology might encourage students to recognize assumptions as opinions and to think beyond commonly held assumptions. Sociological research can develop an understanding of the complexity of social behavior and encourage careful observation and openness to different perspectives. An important aspect of literary research is the understanding that there are not always right answers but perhaps several possible answers. Literary research can develop cultural and social understanding as well as open the mind to new points of view. Professors teach their students to think like scientists, historians, sociologists, or literary critics. Providing students with the ability to apply ways of thinking in various disciplines will prepare them to more effectively address problems and issues they will confront in their careers.

Conclusion

Incorporating research into first- and second-year courses allows students to gain the benefits of research by learning to become good observers, frame actionable questions, explain and defend their ideas, develop tolerance for uncertainty, use evidence, and work collaboratively. The inclusion of course-based research in first- and second-year general education courses is an issue
of equity and social justice. Course-based research that is authentic and accessible can provide every student with the intellectual benefits of undergraduate research. Our communities will benefit when all graduates can apply their research skills and knowledge to the important questions in their professional and community lives.

References


