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Article Title	Charting a Required Senior Capstone: Diverse Scaffolding for Transformative Experiences
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Journal Title	<i>CURQ on the Web</i>
Citation	Coates, E. Lee, Aimee Knupsky, and M. Soledad Caballero. 2014. "Charting a Required Senior Capstone: Diverse Scaffolding for Transformative Experiences." <i>CURQ on the Web</i> 34, no. 4: 10-15.
Link to article on publisher's website	http://www.cur.org/download.aspx?id=3025
Version of article in FSC	Published version
Link to this article through FSC	https://dspace.allegheny.edu/handle/10456/37051
Date article added to FSC	November 4, 2014

Charting a Required Senior Capstone: Diverse Scaffolding for Transformative Experiences

Since its founding in 1815, Allegheny College has had a senior-year capstone requirement for graduation. Over the past 70 years, this capstone has taken the form of a senior project—*independent research that all students complete in their major fields of study.* Here we summarize this capstone experience, examine the curricular and non-curricular structures in place to prepare students for it, and present three case studies reflecting the diversity of scaffolding provided in different disciplines. While we focus on a close examination of our own selected scaffolding strategies, many resources are available that highlight other models for scaffolding research skills in the arts and humanities (Klos *et al.* 2011) and for the integrating of research into social (Larson 2012) and natural-sciences curricula (Karukstis and Elgren 2007; Grabowski *et al.* 2008). We also briefly summarize results from an assessment of our students' senior projects (Schermer and Gray 2012) funded by the Teagle Foundation. We focus on the reported strengths and challenges of our scaffolding practices and discuss potential improvements.

Description, Logistics of the Senior Project

Allegheny does not have an honors thesis so our students' senior capstone projects differ from honors projects or theses at other institutions in that all students, regardless of their academic performance, have the opportunity to conduct original research, scholarship, or creative activities.

While each department has developed its own approach to administering the senior projects, some key commonalities unite the process. For example, all students work with an advisor or "first reader"—a faculty member serving as the primary mentor for the project. The first reader helps to guide the student through the capstone process, provides feedback on drafts of the project's final paper, serves as a consultant for design and analysis, and submits the final grade. In addition, students have a second reader whose primary responsibilities include evaluating the preliminary proposal for the project and assessing the finished product at a final meeting during which the student presents his/her work and then answers questions raised by the two readers. In some departments, the presentation of the student's senior project occurs in a public forum. Depending upon the practices of the department, students may complete the project in one or two semesters.

From the time prospective students begin to consider Allegheny, they learn about the required senior project from admissions representatives, faculty, and students. Although honors theses are quite common at liberal-arts institutions, required senior projects are still relatively rare. Therefore, students who decide to attend Allegheny may do so, in part, for the opportunity to participate in the capstone experience. As we describe below, curricular requirements provide the scaffolding students need to complete their projects, and students are exposed to these requirements in the very first semester of their undergraduate careers.

As a result, conversations among students, staff, and faculty often revolve around identifying ideas for the senior projects, developing the skills to complete them, and sharing tips for "surviving" the experience. The college culture supporting the capstone project is quite strong, shaping the offerings of departments, influencing student and faculty scholarship, and anchoring the liberal-arts outcomes we hope to help our students achieve. Although perceptions of the required project vary across departments, the majority of faculty members indicate a strong commitment to the value of this transformative educational experience (Schermer and Gray 2012).

Curricular Structures Supporting Senior Projects

One of the most successful ways in which Allegheny integrates scaffolding for research across all disciplines and throughout students' time at the institution is through our curricular program called the FS sequence—with FS standing for First-Year/Sophomore seminar. As the catalogue notes, "taken together, the FS program, Junior Seminar, and Senior Project ensure that Allegheny graduates are equipped to think critically and creatively, to communicate clearly and persuasively, and to meet challenges in a diverse, interconnected world" (Allegheny Catalogue 2013-2014, 6). Five required classes tie the FS sequence together, and they move in progression from a general focus on oral and written communication in the first year, to more focused disciplinary expectations within a given field, and finally to the capstone experience of the senior project.

The goals of FS 101 are to familiarize first-year students with the conventions of description and summarization in writing and speaking. By the end of FS 101 (at the end of the first semester), students are ready to analyze research and

argument in writing and speaking and progress to FS 102. In FS 102, learning rhetorical strategies of argument in oral and written communication are key elements. In addition, students learn basic research techniques and are expected to use secondary sources to support their ideas in speeches and writing assignments. At the end of their first year, all students will have written at least one formal research paper, having had the opportunity to assess sources, use library references and databases, and integrate these materials into their chosen topic and analysis.

In their sophomore year, students take FS 201, a class that emphasizes writing and oral communication within a specific discipline. This class may or may not be in their chosen major, although many majors do require a specific departmental FS 201 because it provides students' first opportunity to learn the conventions of research and writing in a specific discipline. In addition, assignments in FS 201 courses are designed to familiarize students with databases and citation styles in their chosen field. By their junior year, all students must have declared a major and must take a junior seminar in that major.

This junior seminar is a continuation of FS 201 and is the place where students delve more seriously into a topic that often produces an idea for their senior project. Usually in the natural and social sciences, the junior seminar is the launching pad for students' proposed senior projects, but even in majors such as English, where the topic of the seminar and students' senior projects are not necessarily the same, all students practice the writing, speaking, and research conventions of their field and apply them in longer, more-complicated writing assignments. Thus, while the senior project is the capstone experience, students begin the process of acquiring the tools to complete it from their first day at Allegheny, regardless of their major or minor.

In addition to the preparation provided by completing the FS sequence, students can elect to complete independent-study courses and internships for academic credit; these activities also provide students with the opportunity to develop the skills needed to complete their senior projects. Internships with community partners provide students valuable hands-on experiences that may shape the focus and direction of their eventual capstone projects. Independent studies may include conducting original research projects and may help contribute to the research program of the faculty mentor. While departmental practices vary, and the skill set necessary to complete an independent study depends upon the field of interest, students may begin to participate in such experiences as early as their first or second year at Allegheny.

Non-Curricular Support Structures

Beyond curricular structures, Allegheny provides competitive summer research experiences for students enrolled in all divisions of the institution, and several opportunities for students to present their work have been developed. Administrative support for these initiatives is provided by the provost's office and the Undergraduate Research, Scholarship, and Creative Activities Office (URSCA). The numbers of students participating in summer research projects (that generally last six to 10 weeks) has increased over the last 10 years, from 28 students in 2004 to 89 students in 2013. Funding, which comes from a variety of sources (endowed funds and external grants), has also increased, from \$57,500 in 2004 to \$247,700 in 2013.

One challenge, if these numbers continue to increase, will be to accommodate all students wishing to participate in summer research with Allegheny faculty. Because expanding summer research is a strategic priority for the college, it is likely that the limit will be the number of faculty members available to mentor students during the summer, rather than the funding available for student stipends and project supplies.

Although summer research opportunities have been more common in the natural and social sciences, Allegheny has recently broadened opportunities, through an Andrew W. Mellon Foundation grant, for faculty-student research in the humanities. Compared to the natural and social sciences, there are few models (Klos *et al.* 2011) for collaborative research in the humanities between faculty members, and even fewer models to guide collaborations between undergraduates and humanities faculty. However, after the Mellon funds became available in the summer of 2013, 15 humanities faculty members and 22 students worked together on collaborative research projects. In addition to summer funding, the grant allows for yearlong programming, professional development, and workshops to help faculty conceive humanities research projects with undergraduates.

Contributing to the research culture at Allegheny are several campus-wide events that have been developed to support and share student-faculty collaborative projects. In addition to a fall poster symposium for students to present their summer research projects, and a spring-semester poster symposium that celebrates the completion of the senior projects, we developed the Allegheny College Research Seminar Series (ACRoSS). This is a series of weekly summer lunch meetings at which students present their projects to an audience of administrators, faculty, and other student researchers and receive feedback. ACRoSS started in the summer

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of 2008 and has grown each year. In 2013, 58 students from 16 departments and programs (art, biochemistry, biology, chemistry, communication arts, economics, English, environmental science, history, international studies, mathematics, neuroscience, philosophy and religious studies, physics, political science, and psychology) presented their projects to an audience that averaged 120 attendees (ACRoSS 2013).

Because students present their work to students and faculty from many disciplines, they gain experience in developing a presentation suitable for a general academic audience, which reinforces the Allegheny curricular emphasis on oral communications. Moreover, ACRoSS also contributes to the visibility of our research culture since audience members usually include staff from the alumni, development, and admission offices, as well as prospective students and their parents.

Case Studies Across Divisions

In the examples below, we highlight three case studies of how departments or faculty use scaffolding to prepare students for their senior projects.

Scaffolding in the Natural Sciences: E. Lee Coates, Biology Department

The curriculum for biology majors is structured to provide students with the research, communication, and laboratory skills needed to succeed in their senior projects. After taking FS 101 and FS 102 (emphasizing oral and written communication) and introductory biology courses, sophomores enroll in “Investigative Approaches in Biology” (FS Bio 201), a laboratory course that emphasizes experimental design, laboratory techniques, analysis and interpretation of data, and written and oral presentation. The course consists of three four-week laboratory modules that use research approaches at different levels of biological organization—molecular/cellular, organismal/physiological, and population/ecosystem. There are no lectures or exams; students are evaluated on the written and oral presentations of their research projects, as well as their ability to work in a team.

Because students rotate through three different research modules in one semester, and prepare and present their findings as a laboratory report and oral presentation, they gain valuable laboratory research experience and begin to develop the skills needed to communicate as scientists. For most students this is their first exposure to investigative or “open-ended” experiments, so in addition to learning specific research techniques, students learn protocol design, use of proper controls, data analysis, and in many cases,

learn to troubleshoot problems encountered during the experiments.

After completing the FS Bio 201 laboratory course, students enroll in a biology junior seminar (Bio 580), which is taught in a small seminar format (maximum of 10 students) and introduces students to the primary literature and the methodology used to address specific questions in biological research. The seminar gives students the skills they need to develop a critical review of the literature and a research proposal. The research proposal is often used as the basis for a student’s senior project. Like the FS Bio 201 course, the junior seminars include independent laboratory research projects, but in this case, projects are more in-depth, extensive, and are usually related to the research conducted by faculty members teaching the courses.

Students are evaluated on their written research proposal and their report on their laboratory project, as well as on their oral presentation of the proposal and laboratory project. In addition, throughout the semester students are assessed on their presentation and facilitation of a discussion of several primary research articles. The junior-year biology seminars are a logical continuation of the focus on speaking and writing that begins in the FS 101, 102, and 201 courses, thus providing the scaffolding that ensures students are prepared for the senior project, graduate school, and their careers after Allegheny.

Scaffolding in the Social Sciences: Aimee Knupsky, Psychology Department

Through my experience mentoring seniors’ capstone projects, I have found that students’ early exposure to a research community and peer-to-peer mentoring help them succeed in the capstone project. Students who have those experiences report feeling more prepared for their senior projects and are able to pose more creative and relevant research questions. However, the students who select such experiences or who are approached by faculty to participate are typically among our higher-performing students as measured by classroom accomplishments, limiting the opportunities for other students who may benefit more from these hands-on experiences. Therefore, I developed practices to broaden opportunities for all students to engage with research, beyond what they might encounter during an FS201 course.

During my second year at Allegheny, I established a group (now called the Psychological Science Brown Bag series) that meets bi-weekly to model the conversations faculty members have with research assistants. For example, sometimes the group critically analyzes recently published articles, paying attention to methodological choices and considering possible fruitful extensions of the work. At other meetings,

students completing their senior projects present their methods, pilot materials, or share their preliminary results. Thus the meetings allow students not currently conducting research to engage in the process by asking questions and providing feedback to those who present their work.

Attendance at the lunch-time sessions is not required, and it is open to all students who want to learn about research. The meetings are advertised in introductory-level courses and participating faculty members encourage their research students to attend. The result is a community that varies in its research experiences and provides opportunities for peer-to-peer collaboration. The sessions are also an approachable, low-stakes entry into research for students who might not otherwise seek out more formal opportunities.

I also have constructed a peer-to-peer mentoring process that matches current research students with those who have not yet had the opportunity to participate. Specifically, students who are conducting senior projects with me can apply to have an assistant, who is generally a first- or second-year student, help them create test materials, test participants, or code data. Because the seniors are responsible for training these students and setting goals, my role as the faculty member is limited to ensuring that the seniors are working appropriately with their assistants and that the assistants are completing their tasks in a timely manner. I also make a point of inviting sophomores to join ongoing research projects. These students are trained by returning lab students (usually juniors) using a syllabus that details the expectations and goals for the semester. For new student researchers, peer-to-peer mentoring has been perceived as less intimidating than working directly with a faculty member, and it can inspire ideas for the newcomers' own research projects.

In addition to receiving help with their current projects, the student mentors also obtain valuable leadership experience and achieve a deeper understanding of their work. Finally, although this process requires faculty oversight, a key advantage has been a reduction in overall workload for the faculty member without significantly reducing the number of research opportunities available for students.

Scaffolding in the Humanities: M. Soledad Caballero, English Department

After a recent departmental self-study, the English department decided to more consciously scaffold research, critical methodologies, and literary theory into its curriculum. I reconceived my mid-level English classes to incorporate research opportunities.

Students take more seriously the practice and skill of researching if it is incorporated throughout the semester. My recent practices are to:

1. require a Modern Languages Association tutorial session with a reference librarian,
2. require students to produce an annotated bibliography and research proposal before writing final essays,
3. model students' production of proposals and annotated bibliographies using examples from former students, and
4. read articles from the secondary literature as a class.

Regarding the library tutorial, students, especially in mid-level classes, have varying degrees of comfort with scholarly databases and, at times, with the library system. Students realize from these sessions that research is trial and error. Often, the best searches for information are the ones that are creative and try multiple phrases rather than simply look for material on a specific author or work of literature. Because students need to see the multiple webs of scholarly conversations that develop around a topic or theme in a literary period, I assign students in mid-level classes to research topics within a specific literary period.

The English department expects its students to write both an annotated bibliography and a research proposal prior to embarking on their senior projects. To facilitate discipline-specific writing on a particular literary genre in mid-level classes, I provide students with my own model for writing both the bibliography and proposal, using examples from former students so that mid-level students see that writing in these forms is not beyond their abilities. I provide explanation sheets for both.

Reading articles from the secondary literature as a class demystifies the practice of scholarly writing and its important techniques and strategies, allowing students to recognize the conventions of writing in English studies. In my classes, my students discuss how the writer incorporates secondary sources, uses primary texts to support arguments, and makes stylistic choices. Learning that disciplinary conventions exist and what they are creates a platform for students' own writing.

Comfort with research expectations, with the genres of research, and with the practice of research during all four years of students' academic careers is key to helping students understand the value, expectations, and pleasures of research. Demystifying the research process in mid-level classes is a tangible, viable way to prepare students for the

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work and intellectual rigor required of them in the junior seminar and, ultimately, in their senior projects.

Outcomes, Challenges, and Future Directions

Beginning in the spring of 2009, Allegheny was one of four institutions that participated in an intensive three-and-a-half year examination of undergraduate research capstones funded by a Teagle Foundation grant (The Senior Capstone: Transformative Experiences in the Liberal Arts, Schermer and Gray 2012). Students, faculty, and staff participated in a series of focus groups, and both students and their faculty mentors completed assessments of individual senior projects. The goal was to gather best practices from a number of campuses, identify benefits and challenges to students and faculty, and to suggest future directions for these capstone experiences. While a comprehensive summary of the Teagle report is beyond our scope here, the grant has highlighted some positive results, challenges, and recommendations for the future.

The main findings of the Teagle study were that doing the capstone project increased students' critical-thinking, communications, and research skills, in addition to improving their academic ability, intellectual engagement, and ability to manage projects (Schermer and Gray 2012; Table 1).

Table 1. Benefits of Capstone Projects

Academic self-confidence and achievement
Critical thinking
Development of speaking and writing skills
Intellectual engagement
Project management skills
Research skills

Further, students representing all disciplines, grade-point-averages, and genders exhibited significant gains in the outcomes shown in Table 1, indicating that all students benefit from the capstone experience (Schermer and Gray 2012). In addition, Allegheny alumni reported being better prepared for a job or graduate school compared to their peers who did not have such a capstone experience. Alumni also reported that the senior project had a positive influence on their intellectual growth and on their personal growth, attitudes, and values. Some of these gains have also been reported for students who participate in summer science research internships (Laursen *et al.* 2010; Lopatto 2010). While some students may not be able to participate in a research internship or independent study due to

academic, financial, or personal reasons, requiring a senior-year research project ensures that all students, regardless of discipline or academic ability, can gain the transformative experiences that result from participation in a capstone project.

While the Teagle study conclusively showed the transformative outcomes resulting from the capstone experience, some important challenges remain, especially in regard to structural support for both students and faculty. One of the challenges is the inconsistencies that can occur across student-faculty mentor relationships. Although the Teagle report indicated that most students developed strong relationships with their faculty mentors, a few students reported dissatisfaction with the feedback they received or they reported that their advisor was not engaged with their projects. While differences in departmental cultures and sizes of classes are relevant factors, an obvious contributor to this problem is the lack of faculty-development programs designed to help faculty learn how to mentor students working on the senior projects.

Some faculty described learning to mentor research students through trial and error or by having informal conversations with departmental colleagues. A second challenge is the different levels of preparedness students bring with them to the senior-project experience. For example, while the curricular scaffolding we have described provides a good foundation, students who come late to a major may not benefit equally from this scaffolding. Moreover, not all students have the opportunity to complete summer research or an independent study or internship for course credit prior to beginning their capstone research. While Allegheny has worked to increase such opportunities, there are limitations for both students and faculty, due mostly to time.

From a faculty perspective, the mandated senior projects require a large investment of faculty time and college resources. Allegheny faculty members do receive teaching "points" for each student they mentor. The primary research mentor generally receives three points; the second reader receives one point. Once the faculty member accumulates 44 points, he or she is eligible for a course release. The number of senior projects a faculty member supervises depends upon the number of majors and faculty in a department. In larger departments, it is not uncommon for faculty to mentor an average of eight senior projects in a given year, making the supervision of students conducting capstones a significant portion of some faculty members' workloads.

Moreover, as more students become engaged in faculty scholarship either prior to or as a part of the senior project, issues regarding the pace and productivity of faculty members' research programs arise. Although these collaborative opportunities provide students with

rich research experiences, they inevitably slow the faculty member's timeline for completing projects and can limit the opportunities for publication and presentation. While many faculty members are committed to student-faculty research, the value of this work has not yet been made explicit in the language of our tenure and promotion guidelines.

Moving forward, several current or proposed initiatives may improve the quality of the senior-project experiences for both students and faculty. For example, recommendations from the Teagle study included developing annual workshops focused on advising students doing senior projects, as well as creating a handbook for Allegheny senior projects. While many departments have manuals for completing the capstones, these are discipline-specific and thus are not helpful for all students. Workshops and an overall handbook could help address the inconsistencies in faculty mentoring and the differences in preparedness of our students. In addition, the faculty body that advises the provost and president on college policies and practices is considering a proposal for inclusion of language in our tenure and promotion guidelines regarding student-faculty work.

Finally, Allegheny recently developed a college-wide assessment of the learning outcomes from senior projects that could help inform our future considerations of curricular scaffolding (SPA 2012). This assessment was designed to be broad enough to be relevant for all disciplines. For example, faculty are asked to consider students' disciplinary proficiency, skills in planning and developing projects independently, ability to evaluate and use information effectively, ability to think in an integrative way, written and oral communication skills, and intellectual development.

We expect that the results of the assessment will be used by departments and programs during self-studies to assess whether the desired student-learning outcomes for the senior project are being met and also to track changes in results when departments initiate any modifications, such as scaffolding strategies, for students doing senior projects. Because the assessment is completed independently by the first and second readers, we may eventually be able to assess the reliability of our measure and discuss which learning outcomes we most value. 

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