

The Senior Capstone: Transformative Experiences in the Liberal Arts

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SUMMARY

The four private liberal arts colleges participating in this study – Allegheny College, Augustana College, Washington College, and The College of Wooster – are distinctive in that they require *all* seniors to engage in an intensive mentored experience (“capstone”) that is designed and executed by the student using the theories, methods, and tools of a discipline, resulting in a scholarly or creative work.¹ While we have long believed the experience to be transformative, the evidence has been largely anecdotal. There have been important questions about the experience that needed to be explored more systematically: What educational and developmental benefits are unique to these senior experiences? What practices lead to a “successful” experience? How do these programs impact faculty mentors? What are the costs, including opportunity costs, of supporting these programs?

The survey reports of capstone students, alumni, and mentors indicate that the capstone experiences typically lead to many of the benefits associated with undergraduate research experiences: development of skills in writing and oral communication, critical thinking, and research; an increased interest in research; an empowering sense of academic self-confidence and achievement; and development of project management skills. On average, other learning outcomes, such as becoming an engaged citizen and developing an understanding from multiple perspectives showed no gains. Although variations emerged, gains occurred broadly at all schools and across academic divisions, GPA ranges, and gender, suggesting that all students can benefit from the capstone experience.

In the tradition of the true teacher-scholar, a significant component of the identity of faculty members who chose to teach at a liberal arts college is their love of working with students. It is not surprising, then, that the main benefits for faculty are the sense of satisfaction that comes when the mentoring relationship is productive, working one-on-one with students, and learning about the topics of student projects. Conversely, working with unmotivated and under-prepared students is a source of considerable frustration for mentors.

The project identified attributes of a successful capstone experience that drive the observed benefits for seniors and their mentors, leading to suggestions for best practices. In the process, we reviewed our own programs and considered areas where improvements might be made.

SECTION 1: INTRODUCTION

There has been a growing belief in American higher education that undergraduate research is an especially valuable form of learning because it provides an authentic context for the development of a broad range of skills associated with important educational goals (e.g.,

¹ Each institution has its own name for the senior experience we refer to here generically as the “capstone.” The experience seniors have on our campuses goes beyond that of a typical capstone course.

written and oral communication, critical and creative thinking, independence, and an understanding of how knowledge is constructed). This belief has been supported by an emerging body of research on the impact of undergraduate research experiences upon learning and attitudes (Taraban and Logue, 2012; Lopatto, 2004; Seymour, et al, 2004; Bauer, et al, 2003; Kardash, 2000). What these studies show is that students make gains both in the development of skills *and* in areas that contribute to lifelong learning. These “dispositional” lifelong learning outcomes point to habits of mind that students are more inclined to use following a high quality undergraduate experience (Lopatto, 2006).

Undergraduate research and capstones are considered “high impact practices,” those educational practices believed to be especially effective in achieving important educational benefits [Kuh, 2008]. A few reports have provided some evidence that a capstone can be effective as a high impact practice (Brownell and Swaner, 2010; NSSE, 2007; NSSE, 2009).

However, the studies on undergraduate research and capstones are based mainly in the natural and life sciences, mathematics, and engineering fields, and concentrate primarily on summer research programs, honors research programs, or research programs for a limited number of undergraduates. By contrast, little formal research² has been conducted on capstone experiences, and even less has been done on capstones required of *all* students.

The four colleges in this study are particularly suited for this exploration because they have capstone programs that require all students to engage in an intensive senior experience resulting in a scholarly and/or creative work that is produced independently by the student, with support from a faculty mentor, using the theories, methods, and tools of a discipline.³ Institutional culture at these colleges is significantly shaped by this commitment, and strategic thinking and decision-making are fundamentally influenced by the existence of the universal capstone program.

We invest heavily in these programs because we believe them to be fundamental to the development of our students. At the same time, however, we acknowledged in the proposal for this study that we had an incomplete understanding of the nature, costs, and benefits of this commitment:

We believed that the senior capstone experience was transformative and laid a foundation for lifelong creativity, learning, and reflection in a way that no other curricular experience provides. However, we had only limited indirect evidence and a history of anecdotal information to support these beliefs.⁴

² Some proprietary studies have been conducted (e.g. Robert E. Shoenberg conducted an assessment of the Senior Thesis Program at Bates College in June, 2000, and as part of Allegheny College’s self-study in 2004 during its re-accreditation process it devoted a full chapter to its Senior Project) and less formal research (e.g. Bonthius, Robert E., Davis, F. James, and Drushal, J. Garber, 1957, *The Independent Study Program in the United States*, New York: Columbia University Press). More recently, Brownell and Swaner (2010) summarized the literature in this area.

³ Allegheny College polled more than 100 nationally-ranked liberal arts colleges and found that only 16 institutions require all students to engage in a capstone experience.

⁴ The College of Wooster surveyed seniors at Wooster and three other colleges in 2008 and found that Wooster students responded favorably and significantly differently from the other colleges. It also found that Independent Study allowed them to think critically and to be creative in ways that they would otherwise not be able. See *The*

We knew that there was variation in the way students experienced the capstone, but we did not know the reasons for that variation. We believed that exploring these differences would help us identify what contributes to a positive capstone experience.

We also believed the experience was transactional and that the faculty mentor could gain from the interaction just as the student did. We wanted to understand the impact capstone supervision had on the mentors.

Each institution devotes substantial resources to support its capstone. We needed to have a better understanding of what those costs were, including the opportunity cost.

We recognized that there is more than one way to implement a successful capstone program, as the four institutions in this study demonstrate. We expected that it would be valuable to identify program commonalities that contributed to successful outcomes.

In November 2008, Allegheny, Augustana, Washington, and Wooster received a grant from the Teagle Foundation to explore these issues. This document is the final report of that study, which we hope will add to an understanding of the benefits and costs of required senior experiences.

RESEARCH AND ANALYTIC QUESTIONS

The project sought to answer the following questions, both generally in terms of capstones required of all seniors and more specifically in term of the capstone program implementations on the campuses of the four participating institutions.

1. What is the impact of the capstone experience on outcomes leading to lifelong learning?

Specifically, we wished to explore the degree to which the capstone experience contributed to the following learning and developmental outcomes.

Being able to plan and conduct an intellectually demanding project – a skill that includes:

- Creative and critical thinking/problem solving skills
- Independence in thought, action and initiative
- Tolerance for obstacles, ambiguities; perseverance
- Time management skills
- Leadership/teamwork
- Acceptance of responsibility

Developing an understanding of one's self and one's interests and capabilities – a sensibility that includes

- Career path clarification and commitment
- Development of an interest in research
- Development of an interest in higher level cognition
- Growth of intellectual self-confidence

Five Colleges of Ohio Creative and Critical Thinking: Assessing the Foundations of a Liberal Arts Education, 2008, report to the Teagle Foundation prepared by Nancy Grace and Sarah Murnen.

Critical reflection on one's own perspective

Understanding of the nature of research and how knowledge is constructed – an outcome that entails

More sophisticated understanding of research practice in a discipline

More sophisticated understanding of how things are known (epistemological sophistication)

Awareness of the interrelationship of knowledge

Valuing different points of view

2. What are the benefits and costs experienced by the student and the faculty mentor? What are the conditions and practices that result in the most positive capstone experiences?
3. What are the similarities and the differences in how our capstone programs are formulated?
4. What resources (programs, structures, and personnel) are our colleges providing to support their capstone programs? What is the institutional opportunity cost of our capstones?
5. What changes to our programs are suggested by the data?

To answer these questions, we began with surveys of seniors and their mentors, both pre- and post-capstone, to gather quantitative summary measures of their experiences, supplemented by textual analysis of responses to open-ended questions. Data was collected from the 2010 and 2011 graduating classes. Alumni two, five, and ten years out were also surveyed about their capstone experiences. These findings were used to guide the design of a qualitative exploration consisting of focus groups with students, faculty mentors, and support personnel.

REPORT OVERVIEW

This report provides some answers to these questions based on the data collected from seniors, their mentors, alumni, and support personnel. Section 2 provides descriptions of the capstone programs at Allegheny, Augustana, Washington, and Wooster. Section 3 focuses on the learning and developmental gains by seniors, the impact on faculty mentors, and the characteristics of a successful capstone experience, which lead to suggestions for best practices. Section 4 provides a summary of our findings in relation to the project research questions and discusses their implications. Finally, Section 5 provides some retrospective thoughts on our experiences in executing a multi-institution assessment project.

ACKNOWLEDGMENTS

We are very grateful for the generous support of the Teagle Foundation and for their ongoing commitment to promoting educational assessment efforts that lead to meaningful change.

We also thank the Higher Education Research Institute, National Survey of Student Engagement, and Center of Inquiry in the Liberal Arts for permission to use selected items from their national surveys, and the Higher Education Data Sharing consortium for the use of their Alumni Survey.

Many individuals contributed their time and expertise to this project as listed on the roster of participants in Appendix A. A large part of any success achieved has come from the fusing of their talent and efforts. These include faculty, deans, and institutional research/ assessment directors, and project consultants. Particular thanks are due to the faculty steering committee chairs for guiding the campus efforts, to the Institutional Research/Assessment directors for the huge task of managing the surveys and assembling the data for our databases, to the consultants on the project, Dr. David Lopatto, Grinnell College, and Dr. Charles Blaich, Center of Inquiry in the Liberal Arts, Wabash College, for their expert advice, to Bruce Colwell for leading the focus groups at the four campuses, and to Dr. Timothy Arbisi-Kelm for the initial textual analysis of the open-ended comments of seniors and mentors. Finally, special thanks go to Augustana College, Allegheny College and The College of Wooster for so ably hosting our planning workshop, and two project conferences.

SECTION 2: CAPSTONE PROGRAM DESCRIPTIONS

Before discussing capstone outcomes, this section describes our capstone programs. It begins with narrative descriptions provided by the four campuses. Following these is a brief analysis of similarities and differences and a comparative table of features based on the four narratives. Next we present the results of two surveys of departments, the first regarding departmental policies and administration for the capstone and the second regarding the specific characteristics of each distinct capstone type available through departments. Finally, the results of items on the student and mentor surveys that relate to the way students and mentors perceive some capstone program practices are discussed.

INSTITUTIONAL DESCRIPTIONS

Allegheny College – Senior Comprehensive Project

The capstone experience at Allegheny College is called the Senior Comprehensive Project (the “senior project,” in the official idiom; the “comp” in the vernacular). For every graduating senior at Allegheny this experience is a sustained independent act of inquiry or creativity consistent, in methodology and focus, with the nature of such work in that student’s academic major. Students doing senior projects in biology and chemistry do what biologists and chemists do, laboratory experimentation guided by hypotheses and research questions; students undertaking political science projects do the quantitative- or theory-based research and discursive work that characterize that discipline; English majors make critical arguments about literary texts or, as creative writers, fabricate their own literature. All senior projects include a substantial written component (even in the case of visual art and music majors), and all conclude with a student’s oral defense or oral presentation of findings before a two- or three-person faculty board. Seniors choose their project topics with varying degrees of latitude (depending on the department or program), and each senior project is guided by that student’s senior project faculty advisor, with another faculty member, designated “second reader,” sometimes contributing to this guidance.

Origin and History

Allegheny has had some kind of required capstone experience for all students since its first graduating class in 1821. Since 1942, successfully completing a senior project as we know it now, including the oral defense, has been a graduation requirement. (In the 1970s, oral examinations shifted from a general defense of disciplinary expertise to a more focused presentation of the Senior Project findings.) Much like the rest of the curriculum, the nature and evolution of senior projects within each discipline has largely been determined by each department, reflecting the evolving practices that characterize academic work in that discipline. From at least its modern inception onward, the senior project has figured centrally in the educational culture at Allegheny. Although it is no longer characterized by the breadth or recapitulative nature suggested by the “comprehensive” part of its name, the Comprehensive Senior Project stands as the culminating experience of undergraduate education at the college. Admissions literature touts it as the pinnacle of independent intellectual opportunity and challenge at Allegheny; the College Catalogue notes that it is “often . . . a pivotal moment

where a student realizes his or her own abilities and potential;” many departments and programs construct their curricula in part to prepare their majors for the senior project; and many seniors, working in disciplines where their senior project research can lead to national conference presentations and even co-authorship of articles with their faculty mentors, make use of the senior project as an asset in graduate school applications and post-graduate employment. Finally, for faculty, the senior project has recently emerged as a site in which they can undertake both interdisciplinary and assessment-based considerations. Over the last five years an average of 15% of Allegheny’s seniors have been double-majors; because most of them do one senior project that combines the disciplines of their two majors, faculty members advising and evaluating such projects have had to define, at least situationally, what successful multi- or interdisciplinary work looks like in that context. (As of yet, such conversations have not been systematic or comprehensive.) Similarly, because it is the most thoroughgoing occasion in which students demonstrate both their disciplinary learning and their possession of broader liberal arts learning outcomes such as effective communication and critical thinking, the senior project is now being considered as the window through which the college can best assess, in a direct way, the success of its educational program.

Educational Objectives

It is fair to say that the Senior Project was initiated and developed at Allegheny before the educational objectives or learning outcomes hoped for from this experience were formulated in an explicit, elaborated, and consensus-based way. Still, it is an institutional fact that the Senior Project is the one sustained occasion when Allegheny students can put into independent practice the analytic, creative, and expressive habits cultivated in their major field(s) of study and in the college’s liberal arts environment more generally. In it students are called on to integrate discipline-specific knowledge with the communication and research skills they have practiced, since their first semester, in the College’s general education sequence of writing- and speaking-intensive seminars. The senior project grading rubrics that departments and programs have been developing in recent years reflect these educational goals.

Administration, Policies, and Procedures

The specific nature and administration of senior projects—their length, methodology, and standards of evaluation, for example, and how students arrive at their topic and are assigned their senior project advisors—are defined by each department and program. There is no central administrative or faculty group regulating these matters. The one exception to this rule is in the determination and distribution of “senior project points” for faculty (see below). The project point system was initiated and defined by the Provost, in consultation with Faculty Council, and the Registrar keeps track of each faculty member’s points total, in consultation with department and program chairs.

Students receive anywhere from 4 to 8 credits for their senior projects. (At Allegheny, a course typically is worth 4 credits.) The most common credit total is 6, spanning two semesters (a two-credit preliminary course experience, in which students do research and develop their project proposal, and the four-credit project itself); 10 of Allegheny’s 22 majors require a two-semester, 6-credit sequence. Seven majors are the one-semester, four-credit variety; three majors offer the option of a one- or two-semester senior project (with total senior project course credits varying from four to eight); one department, Environmental Science, requires a

two-semester, eight-credit senior project experience, and one department, Communication Arts, has a two-semester, five-credit project.

There is nearly the same level of variation in how the specific topics for senior projects are chosen. Some departments take a relatively *laissez faire* approach, inviting students to approach faculty whose expertise matches (exactly or roughly) the focus the student would like to take in his or her project, and the two have a conversation in which, typically, the topic is modified for practical reasons but still reflects the student's original interest. Other departments present categories of topics to their rising seniors (through their website, in a department-wide open house, or in some other way), and students choose a topic within those categories, each asking to work with the faculty member identified with their chosen category. Other departments guide the choice of topics much more firmly, usually through a junior or senior seminar, in which the research focus of that course is extended into the senior project itself. This model suits some natural science departments particularly well since students' senior project work can merge with the ongoing research of the faculty member teaching the pre-senior project seminar in question. Almost all departments also require a senior project proposal—usually that is the culminating product of the two-credit preliminary senior project course—and further practical modifications of a student's topic occur through a faculty vetting of the proposal. This vetting occurs among the student, the designated senior project advisor, and the “second reader,” that is, the other faculty member on that senior project board. In the case of double majors, the discussion over the proposal is especially important, since the challenge of crafting a topic that satisfies two departments at once (in the case of joint projects) can be pronounced. In that case, the two faculty advisors are both senior project directors, one from each department involved.

As suggested above, the senior project topic-selection process is conjoined, in many cases, with the process by which mentors are assigned to seniors. Obviously, in the case of departments where the junior seminar leads quite explicitly to the senior project, the options for students in choosing senior project mentors are limited—limited, by and large, to those faculty teaching those seminars. In terms of the composition of the senior project board, nearly all departments now have two-reader boards: the senior project director (also called “first reader”) and the second reader. In most departments, second readers are assigned by the department chair, working by the principles of relevant expertise and work-load equity. (In joint-projects for double-majors, the two faculty readers are the comp advisors from the two departments in question.)

Allegheny has no formal senior project mentor training program or handbook for faculty, as of yet. They have depended on collegial mentoring (and perhaps institutional osmosis) to bring new colleagues up to speed. In recognition of the teaching and work-load challenges specific to successful senior project advising, it is common practice not to allow first-year tenure track faculty to advise senior projects. Furthermore, some departments help new colleagues learn these ropes by having them sit in on senior project oral defenses. It is also typically the case that non-tenure-track faculty do not advise senior projects; nor do adjunct faculty.

There are no formal expectations or requirements for senior project advising articulated in any college documents. The presiding assumption is that faculty will be guided in this mentoring by

many of the same principles that define successful classroom teaching and academic advising at Allegheny: a demonstrated competence in their field of specialization (citing relevant research in the field, invoking current issues and problems for scholars in this area, placing this subject area within a liberal arts context, being willing to explore new areas of inquiry related to this field); the maintenance of evaluative standards (demonstrating personal and professional integrity, adhering to high standards for student performance, grading fairly); and a willingness to work with students in an advising capacity (being available for student consultation, being sympathetic to student needs). In practice, the mentoring process also adheres to certain conventions. In the Humanities and Social Sciences, students usually meet with the senior project advisors at regular intervals (once every week or two), often to discuss chapter drafts. In some large departments in those divisions, these meetings happen in “comp groups.” The mentoring routine is usually different in the Natural Sciences, organized as that work is by collaborative laboratory work. On the occasions when students “fall behind” in some way—do not turn in chapter drafts by the appointed date, miss lab sessions, fall behind in data collection, etc.—faculty are free to “mentor” as they choose (from contacting and persistently encouraging such students, to granting them complete independence and leaving them alone).

Regarding policies for senior projects that combine two majors: as with the formulation of joint senior project topics mentioned above, how such projects are undertaken is always negotiated by the three parties involved (the student and the two faculty readers from the two departments). There are some rules, though, that govern the parameters of such projects. In terms of credits, a student’s joint project will have its credits “double-counted” in each department, even though this double-counting doesn’t happen, quantitatively, on the student’s transcript. (For example, if a student does a joint German and Music senior project, each department will understand that student to have added 4 credits to his major in their department, but he will not get 8 credits for the project on his transcript.) When the two departments have asymmetrical senior project credit arrangements (a two-course, six-credit sequence in one department and a one-course, four-credit project in the other, for example), the faculty members and student need to negotiate a plan that satisfies both departments. Finally, on the specific question of which department’s deadlines (for the proposal and the final draft of the project itself) obtain, the major that the student lists first in the major declaration form dictates on this subject.

There are two standard ways that senior project grades are determined. In most departments, the faculty board (the project director and the second reader—and, on rare occasions, a third reader) confers directly after the student’s senior project oral defense and arrives at a grade. A few departments think of such grades as provisional. At the end of each semester they meet to discuss all the senior projects in the department that term, along with the provisional grades they received, with the intention of having these discussions “norm” the grades across the department. Most departments (no matter which of the above two paths they take to grading senior projects) have created senior project rubrics which also help to systematize such grading. Most departments also have senior project guidelines which they distribute to their majors; these guidelines spell out the department’s expectations for senior projects, along with enumerating protocols (such as manuscript formatting), deadlines, and “late-comp” policies.

Senior projects that are completed after the deadline will receive a grade penalty that is usually stipulated in a department's guidelines.

General Requirements and Expectations

Not surprisingly, departments provide most of the course work required of the major as prerequisites for the senior project. (The three-course writing- and speaking-intensive seminar sequence, required of all first and second year students, can be said to begin all Allegheny students' preparation for the senior project.) With one exception, every major requires a junior seminar. (In Religious Studies this course is required but is designated a "Group Tutorial," in deference to the heterogeneity of methodologies and content areas in this field; in three interdisciplinary majors—Biochemistry, International Studies, and Neuroscience—a junior seminar in one of the contributing departments is required.) The junior seminar is the closest Allegheny comes to focused, college-wide curricular preparation for the senior project. In many departments, junior seminar work includes the first stages of students' work on the senior project research and proposal; in many others, the seminar includes a substantial research project akin to senior project work, so that students practice the methodology of senior project work, even if they don't begin work on that very project.

As we have noted, all senior projects include a written document and an oral defense or presentation when the project has been completed. The College now archives these documents electronically, in "D-space," an archival system that is password-protected and accessible to all faculty and current students. (Older senior projects are stored as hard copy in departments or the library.) These documents can vary in length and substance, of course, given different disciplinary conventions and methods. (English and history majors have written 100 page theses; mathematics majors have submitted twelve pages of original, elegantly proven theorems.) For some majors, the written document complements another original artifact or representation, such as a piece of visual art, a musical performance or original composition, the performance of a theatre major's original play, or a poster summarizing research findings in a biology senior project.

The College has for the past six or seven years hosted some version of a senior project celebration, during which select students have presented, in abbreviated form, the senior project to a wider audience. They have not canceled classes during these events, however, so attendance at them has been uneven. The Curriculum Committee is currently working on a revision of the academic calendar that includes a "protected day" at the end of the school year when such presentations can occur and draw a wider audience. It should be noted that a few departments hold their own version of such events, with seniors making poster presentations about the senior projects to students and faculty in the department. For these departments, such presentations constitute the main "oral" component of the senior project experience and are in keeping with the dissemination practices in such fields.

Resources

Six years ago the Provost initiated a point system by which faculty could be compensated, through course releases, for advising senior projects. The formula of this compensation equates every senior project (no matter its duration or course credit equivalents) with 4 project points. In single-major projects, the faculty advisor usually receives 3 points, and the second reader

receives one. In a joint project, the two advisors typically divide the 4 points in half. When a faculty member has accumulated 44 points, he or she becomes eligible for a course release, the timing of which is negotiated by the department chair and the Provost, depending on departmental circumstances. (Project points cannot be so “saved up” so that a faculty member receives more than one course release at a time. On the other hand, project points can theoretically be “banked” indefinitely.) The Registrar tabulates the “earning” of such points and informs faculty of their totals each semester.

In terms of the expenditure of faculty effort and time in service to the senior project, it is difficult to generalize accurately, since disparities in this area exist not only across departments but within them—and, at times, for individual faculty members, since each student compels his or her own amount of attention, guidance, and routine interaction. Still, speaking impressionistically, it is fair to say that directing five or six senior projects in one semester for many faculty members can approach the expenditure of time and energy required for teaching a stand-alone class. In the departments with the highest number of majors, Psychology and Biology, faculty can advise up to 10 or more senior projects at a time. While these departments have devised efficiencies, such as “comp” groups that meet once a week as a kind of class, senior project advising in those cases can seem fully equivalent to teaching another four-credit course (adding roughly 33% to a faculty member’s teaching load). Conversely, in departments with low majors-to-faculty ratios, senior project advising of course adds much less to the faculty workload, though in a few such “richly staffed” departments, faculty have developed very time-intensive mentoring arrangements.

In terms of the institutional (and specifically staffing) costs of mandating senior projects, finding a numerical answer implies a precision that is finally illusory or at odds with reality. Our Registrar is quite insistent on this point. Given that substantial caveat, however, we can say the following:

- Each senior project is worth 4 senior project points for faculty⁵
- 44 project points is equivalent to a course (ostensibly in the form of a faculty course release)
- Most courses at Allegheny are worth 4 credit hours
- 11 senior projects are roughly equivalent to one regular course, carrying 44 total credits hours
- The current Allegheny Fact Book lists the average class size at 17, meaning, on average, a regular class generates 68 student credit hours
- Therefore, in terms of credit hours, the ratio of one senior project “course” equivalent to one regular course is 44:68 (or 11:17), meaning, on the staffing side, that it is about half again as expensive to “teach” senior projects as it is courses.

For students there are funds designated to support their work in the senior project. Some departments, such as Computer Science, have budget lines that can, to a modest degree, be used to underwrite the purchase of materials and other necessities for student projects. The

⁵ While directing a senior project generates 3 project points, not 4, we’ve “rounded up” because in the course of advising 11 projects, most faculty would have also been second reader (a 1-point endeavor) as often, making up the “gap” between 33 and 44 points in the process.

Allegheny College Center for Experiential Learning can help fund students' travel to conferences in which they present research undertaken in their senior projects. On rare occasions the Allegheny Student Government can also be a funding source for senior projects. Finally, the "Class of 1939 Senior Research Fund," managed by the Provost, underwrites research and other senior-project-related expenses for students; these awards are usually capped at \$500 per student. In terms of infrastructure or staffing, though, there are no designated facilities or technical support colleagues exclusively devoted to supporting senior project work.

Augustana College – Senior Inquiry

The capstone experience at Augustana College is called Senior Inquiry (SI). In most disciplines students produce a culminating project in an inquiry-based curriculum that asks them to synthesize, analyze and reflect on their course work in the major, their broad college experience and its relationship to the needs of the community. The Senior Inquiry structures developed by various department and programs include a variety of models, such as traditional independent research, internships, literature reviews and analysis, civic engagement projects, and student teaching. The reflection component asks students to assess how their projects contribute to the intellectual, social, and physical communities of which they are a part, and how they could make a difference in those communities.

Origin and History

While approximately half the programs at Augustana had for many years included some sort of senior paper or project, these varied widely. In the early 2000's our outcomes assessment data (particularly NSSE) indicated that the college needed to take steps toward formalizing and expanding its capstone expectations.

In 2005, the dean and a group of faculty drafted a proposal to create an institutional response to the identified need. Ultimately, a committee of faculty led by an associate dean developed guidelines that were approved by a vote of the full faculty and that departments and programs would use in designing a capstone requirement for their program, with proposals to be submitted for review. Specifically, Senior Inquiry was expected to be:

- Substantial in meaning and impact
- Communicative of the discoveries made through the project
- Reflective of one or more of the following:
 - the nature of knowledge and inquiry
 - self-awareness and connection with others
 - the relationship of individuals to a community

In addition to these outcomes, departments and programs were encouraged to design offerings that enable students to integrate two or more of the general education dispositions (attributes such as life-long learning, responsible citizenship etc.) Given the breadth of these outcomes, departments selected the particular goals most relevant to the major. Departments and programs were expected to build assessment strategies into their proposals.

Starting in 2006, departments and programs began work on creating their Senior Inquiry proposals. Typically, this involved careful examination of existing curricula to insure that

students would be prepared for their senior projects and the redesign of the major to include appropriate supporting courses. Multiple models (i.e. traditional research; internship; civic engagement project) for the capstone experience were encouraged. Projects could extend beyond a single term. If a proposal requested additional staffing, it needed to be approved by the dean. Proposals were then vetted through a faculty committee and passed through the normal channels of faculty governance for approval. As of this writing in 2011, approximately 90% of Augustana students complete a Senior Inquiry project with more being added each year as departments and programs implement their proposals.

The unique feature about Senior Inquiry at Augustana is its reflective component. A significant portion of final papers and presentations focus on the students' metacognitive interpretations of their learning, not only during the SI project but also as it connects to their course work at Augustana. Students are also expected to assess how their projects contribute to the intellectual, social, and geographic communities of which they are a part, and they are asked to consider how they have and could make a difference in those communities.

Educational Objectives

The objective of the SI process was that the student would demonstrate integration of knowledge within a discipline with all aspects of the Augustana experience and beyond. A goal is that programs would enhance meaningful one-on-one relationships between students and participating faculty and staff. These very broad, college-wide parameters were operationalized by the individual departments and programs. Outcome statements typically discuss understanding foundational knowledge and skills, engaging in meaningful research, communicating results in both written and oral forms, and reflecting upon expertise in the major and integration of the liberal arts.

Administration, Policies and Procedures

The administration of the Senior Inquiry program is quite decentralized. Each department or program has negotiated its own parameters in terms of credit requirements and load credit for mentoring. Sometimes if more than one option for SI is offered, these can vary even within the department or program. Three are the fewest credits required for SI, and nine credits are the most. In 2010-11, 1,309 credits of SI were generated with 133 credits of assigned faculty load. Overall, 9.8 student credits were generated for each credit of faculty load, but this varied widely by department and program. In contrast, regular upper division courses generate about 20 student credit hours per credit hour of faculty load. In some cases, faculty members were supervising/mentoring 3 students while in others it was 15-20.

Most frequently, departments create a designated SI course or courses that are included in the course catalog and scheduled for one or more terms with a designated instructor. Students register for the SI courses as usual and are all mentored by the course instructor.

Probably because the SI program is relative new, the faculty role is not as defined as it might be, and mentoring has not received a great deal of attention. Departments and programs assign mentors in many different ways. In some areas, the students are dispersed across departmental faculty so that every faculty member oversees projects. In other areas, certain faculty mentors are assigned to the designated courses, and this assignment rotates through the department. Preparation for the faculty mentoring experience tends also to be handled within the

department or program. Faculty will typically share syllabi and other resources. Choice for the SI focus also varies by department. In some instances, the topic is selected by the faculty member, but mainly students choose their projects. In almost every department/program, faculty members attend the students' final presentations, and in many cases also participate in grading them using a common rubric.

Student experiences also vary widely both before and during the SI experience. Project requirements also offer alternatives. While the most common type of SI is a traditional research project, paper and presentation suitable to the field, students in many departments/programs have options. The English Department, for example, offers a series of seminars from which students can choose. The Religion Department requires an internship or community based project before students enroll in the course where they research, write and present their papers. In Business Administration and Multimedia Journalism, students can elect to complete an internship and accompanying reflective component. Students in Psychology and Communication Studies may opt to do a community-based project. In Biology, students choose from a literature-based inquiry (resulting in a literature review or grant proposal), laboratory or field research, or an off-campus research opportunity.

Students who are double majors are similarly confronted with a variety of scenarios. Some departments/programs substitute an upper division course if the student is completing their SI in another area. Other departments/programs collaborate to offer an interdisciplinary option that pulls the student's areas of interest together. Finally, some departments see the SI as an integral component of the major and require that all students complete it even if they are also doing one elsewhere on campus.

Grading uses the standard A-F grading system. A pass/fail option is not available. If a project extends beyond one term, departments/programs can decide if each term will be graded separately or if the final project grade will be awarded at the end.

Student Preparation

Departments were expected to examine how they would prepare students for SI. The Biology Department, for example, thoroughly revamped their offerings according to a model they had developed called IRIS (Integrated Reflection and Inquiry in the Sciences). First year students now take a course called "Becoming Biologists" in which they explore what it means to enter the discourse of their discipline. Communication Studies requires that students select three of nine different one-credit methods modules prior to the senior year. In Art, students plan for their senior exhibit during a junior year course. Psychology and Sociology students complete a research methods course.

Celebrations/recoqnition for completed projects

A campus-wide "Celebration of Learning" is held each spring as one venue for students to present their project results as a talk or poster session. Individual departments also sponsor presentations open to the campus. Students are encouraged to present at student research conferences sponsored by various disciplinary societies.

Assessment

As a part of the SI proposal, departments were asked to describe how they would evaluate their final projects. Many departments/programs use the final project as an indicator of student learning. For example, all faculty members in the department attend the final presentations and evaluate each on a common rubric. They draw upon observed strengths and weaknesses to modify their curriculum and pedagogy.

Resources

The staffs at the Tredway Library and the Reading-Writing Center have been instrumental in assisting students. They have offered special instruction in databases and bibliographic software. They have also worked with students on writing their final papers.

A number of financial initiatives have been institutionalized to support SI. Some students choose to use “Augie Choice” funding to support their senior inquiry. “Augie Choice” is a \$2,000 grant for which junior and senior students can apply if they are conducting research, completing an internship, or studying internationally. In 2010-2011, 16% of the students used this grant for research. Faculty can also apply for summer funding when doing research with students. Some departments allow students to complete a summer REU at other institutions as a means of fulfilling the SI expectation. Finally, the dean has recently established special funding to enable students to present their research at state, regional, and national conferences.

Washington College – Senior Capstone Experience

All Washington College students have been required to complete some form of senior capstone since the 1959-1960 academic year when the college moved to the current four-course plan. The exact nature of the capstone has always varied across departments, largely as a reflection of the many different modes of inquiry existing at a liberal arts institution. Until the 2006-2007 academic year, the capstone experience was known as the “Senior Obligation,” and neither students nor faculty received course credit for completing the obligation. Due to growing student and faculty concern over workload issues, the Faculty Affairs and Curriculum Committees began discussing changes to the obligation in 2005, and generated a proposal that was approved by the faculty and the Student Government Association in the spring of 2006. Beginning in the fall of 2006, the Senior Obligation became known as the “Senior Capstone Experience,” students began receiving four credits for completing the capstone, and faculty began receiving one course credit for every 12 capstones they supervised.

Educational Objectives

As stated in the Washington College catalog, the Senior Capstone Experience (SCE) “requires students to demonstrate the ability to think critically and to engage in a project of active learning in their major field of studies. In the SCE, required of all graduating seniors, students integrate acquired knowledge and skills in a senior project demonstrating mastery of a body of knowledge and intellectual accomplishment that goes significantly beyond classroom learning” (p.38). While the specific design of the capstone may vary, all capstones “will be informed by the following expectations:

- Demonstrated student initiative

- Significant preparatory work
- Active inquiry
- Integration of acquired knowledge and skills
- Culmination of previous academic work” (p.39)

For most students, the SCE also represents the culmination of four years of writing at Washington College that begins with a two-semester sequence of writing intensive courses in the first year, continues with two semesters of writing intensive courses in the sophomore and junior years, and ends with the capstone.

Administration, Policies and Procedures

Washington College’s SCE program is administered almost entirely at the department level. We have no SCE committee, no lead administrator for the program and no college-level administrative oversight of any sort. Although our college catalog states that, “The Curriculum Committee will review, at regular intervals, departmental policies regarding the Senior Capstone Experience to ensure compliance with the expectations listed above and overall equality of demands across departments,”(p.39) such a review has not yet been conducted.

In the absence of centralized oversight, details regarding capstone policies are determined by departments, resulting in substantial variation across the college. While the College has always been aware of this variation and, to some degree, has even considered it to be a strength of the program, the degree of variability and its effects on students and faculty were not fully understood until the college participated in the Teagle-funded Capstone project.

At Washington College, all students complete the SCE, all receive 4 credits for doing so and all faculty receive either a course release or a small stipend for every 12 capstones they supervise; aside from these constants, all other aspects of the SCE vary by department.

For example, departments report that students work on their SCE’s between 2 and 25 weeks (\bar{X} =13.56). Also, while 30% ($N = 7$) of departments allow students to choose the topic for their SCE, 65% ($N = 13$) rely on a process of negotiation between student and mentor. The final topic is usually allied with the faculty mentor’s interests and expertise (65% indicated that this occurs “usually” or “always”), but is much less likely to be allied with the faculty mentor’s research (21% indicated that this occurs “usually” or “always”). Perhaps in part due to the high level of inter-departmental variation, no college-wide mentoring or training of SCE mentors occurs, and there are no college-wide, formal expectations or requirements for mentors. However, many departments engage in informal mentoring of new SCE mentors during which the departmental expectations and requirements are made clear. Such mentoring is usually at the discretion of each department chair, and to the best of our knowledge neither the college nor any department has ever produced any sort of handbook for mentors specifying these expectations and requirements.

Similar variability exists in the selection of faculty mentors with 48% ($N = 11$) of departments reporting that mentors are chosen by students, 30% ($N = 7$) reporting that pairings are negotiated between students and mentors, and 13% ($N = 3$) indicating that students are assigned a mentor by the department. In addition, in one department all faculty mentor every student and in another one faculty member mentors all students. Students usually do get their

first choice for mentor (83% indicated that this occurs “usually” or “always”), and when they do not, it is usually due to a need to equally distribute the mentoring load.

Grading policies are also variable with most departments (75%; $N = 12$) utilizing the Pass/Fail/Honors system that had been universal before 2006, and a few departments (25%; $N = 4$) utilizing traditional letter grades plus Honors. Also, 47% ($N = 9$) of departments have only the mentor grade the SCE, 26% ($N = 5$) also use a second reader, 21% ($N = 4$) require the entire department to grade each SCE and 5% ($N = 1$) employ a departmental committee. Most departments (63%; $N = 10$) reported that they employ a grading rubric to determine capstone grades, while a significant minority (37%; $N = 6$) reported that they did not.

Finally, double majors complete a single, combined capstone about 50% of the time. Whether the capstone is combined or separate, each faculty mentor receives full credit (1/12) for that student, but the student receives only one course credit.

General/Core Requirements

The only college-wide requirements are that every student must earn a passing grade on the SCE, that the SCE must be completed by the last day of classes in one’s senior year, and that the student must electronically submit the completed SCE to the library.

Student Preparation

Of the 16 departments at Washington College completing our capstone Departmental Administration survey, 69% ($N = 11$) reported that they offered a course specifically designed to prepare students for the capstone. Depending upon the department, these preparatory courses include Junior Seminars, Senior Seminars, and various research methods courses. Virtually all of these preparatory courses involved learning methods useful for the SCE, determining the SCE topic, developing a capstone proposal, starting work on the SCE, and refining discipline specific communication skills. About half included assigning students to SCE mentors, and only 12% ($N = 2$) prepared students for a comprehensive exam.

Description of Capstone Types

Capstone types vary widely across departments, but also within departments. Of the 15 departments responding to this question, 47% ($N = 7$) offer more than one capstone option; five departments offer two options, while two departments offer three options. The available types are listed below.

- Traditional thesis (all Departments offer this as an option)
- Visual thesis (Art)
- Curating thesis (Art)
- Comprehensive exams (Art, Biology, Economics, English, Modern Languages)
- Drama Production thesis (directing, performance or design)
- Playwriting thesis
- Solo recital (Music)
- Extended composition (Music)
- Lecture recital (Music)
- Programming project (Computer Science)
- Strategic analysis of a firm (Business Management)

- Experiential (Business Management)
- Experimental capstone (Biology, Chemistry, Psychology)

Celebration/recognition for Completed Capstones

Unfortunately, Washington College does not have a college-wide celebration, but a number of departments host events for this purpose. For example, the Biology, Chemistry, and Psychology departments host separate poster sessions in which seniors present their completed SCE's to other students, faculty, administrators and parents. Also, students completing a visual thesis present their work at the Annual Student Art Show, Drama students present their productions, and all students submit their capstones to the college library's online database.

Formal Assessment Structures for Evaluation of the Capstone Program

The college engages in no formal assessment of the capstone program. The course is not evaluated by students using our standard course evaluation form (nor could it effectively be evaluated using this form). Some departments engage in yearly, informal evaluations of their programs, typically through intra-departmental discussions of the strengths and weaknesses of graduating seniors. As mentioned above, the college catalog does state that the Curriculum Committee will periodically evaluate the SCE program, but such an evaluation has not occurred since the creation of the new SCE program in 2006.

Resources

Faculty members at Washington College receive either one course credit or a stipend (\$3,000) for every 12 SCE's they mentor. Credits are tracked by Department Chairs and by the Registrar, and faculty must take the course release or stipend when they reach 12 credits (i.e., they cannot "bank" 24 credits and take two course releases). The decision, in 2006, to begin giving faculty course credit for supervising SCE's was intended to provide faculty with more time to devote to capstone mentoring. However, the college has always struggled to find and fund qualified adjuncts to cover course releases, so the majority of faculty members choose to take the stipend, thereby defeating the purpose of the course credit.

The 12 to 1 ratio was chosen to reflect the College's advertised 12 to 1 student/faculty ratio, but may not be an equitable rate when the SCE workload is compared to the workload for a typical course. Faculty reported meeting with each SCE student for an average of 1.41 hours per week, and spending an average of 2.88 hours per week working on all aspects (e.g., meetings, reading drafts, etc.) of each SCE. This means that faculty mentors are meeting with SCE advisees for an average of 17 hours per week (1.41 x 12) and working almost 35 hours per week (2.88 x 12) for one SCE course credit, but meeting with students for only 3 hours per week (and certainly working something less than 35 hours per week) for one typical course.

As for other resources related to the SCE, most departments reported that students received no funding support, though Chemistry and Drama reported providing funding to 100% of SCE students, and Biology, Psychology, and History reported funding 20-30%. Two departments mentioned inadequate library resources for supporting capstones, and three suggested increased funding to support student conference presentations. While we have no funding sources specifically devoted to the SCE, some seniors do receive support for their projects through the Cater Society of Junior Fellows, and through several fellowships.

The College of Wooster – Senior Independent Study

Wooster's Independent Study program (I.S.) has been a graduation requirement of all seniors since its introduction by President Harold Lowry in 1948. Completed in the area of the student's major(s), the program's emphasis is on the development of independent critical and creative thinking skills that are the foundation for learning throughout life. Over two semesters, each senior works individually with a faculty advisor (the "first reader") on a topic agreed upon between the student and the advisor, culminating in a thesis or creative project, and defended in an oral presentation. Students with two majors either complete a thesis in each department or, more commonly, complete a single thesis on a topic acceptable to both departments. Often the student's work contributes to a larger ongoing research area and is eventually made public through presentation at professional meetings, in peer-reviewed journals or in creative periodicals, or it may be continued in graduate school.

The theses are due on "I.S. Monday," the first Monday after Spring Break, and are evaluated by the I.S. advisor (the first reader) and a second reader who is typically another faculty member from the department of the student's major. A more recent addition to Wooster's I.S. tradition is the Senior Research Symposium, an event for seniors to share their work with the campus and local community. The symposium is held one Friday late in the spring semester, and all classes are cancelled. In order to provide the time needed to advise seniors, I.S. advisors receive a single course release for every five seniors advised over an academic year.

Origin and history

When Howard Lowry left Princeton University in 1944 to become president at Wooster, he brought with him the belief that Princeton's independent study program should become an integral part of Wooster's curriculum. Lowry argued that the most effective learning occurs through the independent effort of the student; that personal development is more than acquiring subject matter knowledge; and, that grappling with the basic problems of scholarship gives the student the confidence and abilities necessary for lifelong learning. As a fundamental component of a liberal arts education, Lowry also believed that participation in the program should be a requirement of all students.

The curriculum was revised in 1948 to include a four-semester, twelve-credit program in independent study. All seniors sat for a senior comprehensive exam to test disciplinary knowledge (a check on breadth within the discipline) and a field examination to measure progress in the area of the student's project (a check on depth). By 1953, the comprehensive exam was largely gone and the field exam had become an oral defense of the thesis in many departments and in others a written response to questions about the thesis. Eventually the Independent Study program was reduced to three semesters and a required Junior Independent Study was instituted as a prerequisite for registering for Senior Independent Study in the senior year.

From the beginning departments were given latitude in how they implemented the program, including how topics were selected, how mentors were assigned, how the mentoring was done, and how the final grade was determined. Over time each department has produced a system that reflects the discipline's unique ways of thinking. Indeed, I.S. is regarded as moving students from *studying* in a discipline to *practicing* in a discipline. Today, Wooster faculty members

regard I.S. as the culmination of a four-year academic journey and as a framework for thinking and inquiry that brings cohesion to the curriculum.

Most assessment within the disciplines at The College of Wooster began with the development of rubrics to assess the written I.S. thesis, the oral defense, and/or the I.S. process. For example, in the Philosophy Department, the Junior I.S. is considered the critical point in the curriculum in which a student begins to transition from *studying* philosophy to *doing* philosophy. Assessment practices in the Philosophy Department, which involved the development of several rubrics and the use of primary trait analysis at key points in the department's I.S. process, have played a vital role in the design of the department's Junior I.S. course as a research seminar encouraging this transition. (See Rudisill, J. "The Transition from Studying Philosophy to Doing Philosophy." *Teaching Philosophy*, v. 34 Issue 3, 2011, p. 241. Dr. Rudisill was awarded the 2012 Lenssen Prize for the best published article on teaching and learning in Philosophy in 2010 and 2011.)

Educational objectives

Several documents describe the rationale and general goals of the Independent Study program. An enduring aspect of the I.S. Program has been the creation of a body of scholarly and/or creative work that is completed independently by the student using the tools and theories of a discipline and that advances or otherwise contributes to a field of study.

The current curriculum, "A Wooster Education," was adopted in 2001. Consistent with the rationale given when I.S. was introduced, "A Wooster Education" describes I.S. as epitomizing the goals of a liberal arts education, the heart of which is the development of engaged and independent learners.

Similarly, Section 3 of the Faculty Handbook which contains the "Handbook for Independent Study" places I.S. in the context of a liberal arts education: "The capacity for individual inquiry and expression is a mark of a liberally educated person, and the objective of the Independent Study program is to provide an opportunity through which this capacity may be nurtured." (Faculty Handbook, Section 3, p. 2)

A study of Wooster's independent study program was initiated in 1953. The preface to that work provides a justification for the creation of the program and is remarkably relevant to today's thinking:

Another basic consideration is the need for men and women with initiative, imagination, and independence. We live in an age of mass communication which tends to breed conformity. At the same time there is greater need for men capable of original thinking than ever before. The tempo of social change today, imposed by advancing science and technology, is certainly without precedent in all our history. Adjusting to these changes will require leaders of imagination, creative intelligence, and critical judgments. Without them social stability and progress will be jeopardized. Thus society has a stake in the kind of education that develops originality, creativity, and independence. (p. viii)

Every department or program that offers a major has an I.S. handbook specific to its majors. Some of these handbooks include the learning goals for the major and, at least indirectly, places

I.S. in the context of those goals. No handbook offers specific learning goals for its I.S. However, in most departments the learning goals and I.S. come together in the rubrics that are used to evaluate I.S. theses.

Administration, Policies and Procedures

Institutional oversight: There is no central committee charged with overseeing the Independent Study program. Issues relating to the Independent Study curriculum are discussed by the Educational Policy Committee. No review of the I.S. program has been done in recent memory.

Student Course Credits: In most departments Independent Study is a three-course sequence beginning with Junior Independent Study (I.S. 401), which is a prerequisite for registering for the first course in Senior Independent Study. A few departments lack a distinct Junior I.S. course, choosing instead to incorporate Junior I.S.-like elements into a course in the major that students typically complete in their Junior year. For all students, Senior Independent Study consists of two courses: I.S. 451 in the fall and I.S. 452 in the spring. A “Satisfactory” must be received in I.S. 451 in order to register for I.S. 452. Each full course at Wooster is considered to be the equivalent of four credit hours, so all Senior I.S. count for eight credit hours. Double majors completing a single I.S. will register for 451 in one department and 452 in the second department.

Faculty Teaching Credits: The teaching load at Wooster is 5.5 teaching credits per year. Faculty members receive one course release for advising five IS students in both IS 451 and 452. The course release is taken in the academic year the students are advised. Faculty members may “bank” teaching credits. Hence, a faculty member advising seven students may take a single course release and bank the remaining .4 credit hours (0.2 x 2 semesters). In a subsequent year, the faculty member might advise three students and draw on their banked credits to get a full course release.

Topic selection: The process used to determine the student's I.S. topic varies by department, but is student-driven and negotiated with the advisor. The degree to which topic selection is student driven varies by department. Many departments hold a meeting of rising seniors to discuss how I.S. is done in the department. This is often when the department’s I.S. Handbook is made available and students have an opportunity to ask questions about the process and possible topics. Faculty share their interests and ideas for I.S. topics through their department’s handbook, on the department web page, through individual meetings with students, or through a meeting with rising seniors.

Some departments require the student to identify their topic by the end of their Junior year while others leave the selection to the beginning of the Senior year. Some departments allow the student to pursue a topic developed in their Junior I.S., while other departments require that the student pursue something different. Students in the sciences are more likely than students outside the sciences to work on a topic close to their advisor’s research area.

Project types: The expectations for the Senior Independent Study project vary by department. In Psychology, seniors must complete an experimental data-gathering project with a clear manipulation of at least one independent variable. In Physics the project must extend our knowledge of physics using at least one of the following techniques: experiment, simulation,

theory. Some departments allow a wide range of Independent Study project possibilities. In English, for example, a student can do literary analysis, write a collection of short stories or poems, write a novella, pursue film studies, do newswriting, write a memoir, or write a piece of creative nonfiction. In history, in addition to the traditional historical monograph, a student can produce a film documentary, produce a public exhibition, write an historical novel, or develop a high school curriculum. The Theatre and Dance departments support projects that are traditional thesis-based, or based on acting, directing, technology and design, stage management, modern dance or play writing.

I.S. Advisor selection policies/methods: The pairing of a senior with an I.S. advisor differs by department; considerations include student and advisor preferences, the student's topic, and the need to distribute the advising load. In some departments the pairing occurs during Junior IS and in others students submit a list of ordered preferences and an effort is made to match the student with his/her highest preference. In other departments, faculty will accept students on a first-come basis until the faculty member has reached his/her I.S. advising load for the year. It is possible for the I.S. experience to be the student's first time working with a faculty member or for a student to be assigned to first year tenure track or a visiting faculty member.

Expectations/requirements for the mentor: Section 3 of the Faculty Handbook, which contains the "Handbook for Independent Study," outlines the expectations of the I.S. advisor, including:

- helping to identify a topic that will challenge the student, but is doable given the student's abilities and the resources available;
- meeting with the student on a regular basis (3/4 to 1 hour per week on average, but this varies greatly by department) during which the advisor helps guide the student toward successful completion of his/her thesis;
- assisting with editing of the thesis; and,
- providing the student with a written evaluation of the final work submitted.

All faculty members are expected to submit course evaluations for two different courses each year. However, few departments systematically evaluate faculty as I.S. advisors. An informal evaluation is done as part of the renewal, tenure, and promotion decisions at which time the faculty member is asked to provide a list of I.S. advisees who might be asked to comment on the quality and nature of the faculty member's advising.

Grading policies/processes: Work done in Junior I.S. is graded using the normal grading scale. The Senior I.S. thesis is graded "No Credit," "Satisfactory," "Good," or "Honors." The final grade is decided on the basis of the work accomplished during each of the semesters, the quality of the completed thesis, and the oral defense of the thesis. Each thesis is evaluated by at least two faculty members (the first and second readers; the first reader being the student's I.S. advisor), who jointly assign the grade. Some departments hold a meeting to discuss assignment of I.S. grades. Where there is disagreement that cannot be resolved by the first and second readers, a third reader may become involved.

General Requirements and Expectations

The Handbook for Independent Study in the Faculty Handbook describes the three elements that make up an Independent Study thesis or equivalent project:

Content - Students differ in their individual interests and the requirements for various courses of study are not uniform; consequently, there are few rules for the proper choice of content for I.S. projects. A well-selected thesis or project should be governed by such consideration as the significance of the subject for personal intellectual development, the progress of professional understanding, and the needs of society. Given the constraints imposed by available resources and time, the manageability of the topic is also an essential consideration.

Method - Implicit in every inquiry is a method or plan which includes a logic, a design, or a deliberate conception of what is being attempted. The method selected will determine the techniques, devices, or tools appropriate for the project.

Form - The successful completion of the project requires the communication of what has been discovered or developed. Through the form of the thesis or creative project, students share with others the results of their efforts. Whether by exposition or through an act of creative expression, the forms of communication should be consistent with the content and method and should be chosen carefully to communicate as clearly and forcefully as possible the results.

Typically there is an oral defense of the thesis.

Within this context, each departmental I.S. Handbook provides additional requirements.

Student Preparation

Independent Study is regarded as the culmination of a four-year program. The general education requirements and courses taken in the student's major are intended to prepare the student for Senior Independent Study by developing disciplinary expertise, critical and creative thinking skills, and communication skills.

Most departments require their majors to successfully complete a research methods course (often designated as Junior I.S.) before being allowed to register for Senior Independent Study. In some departments Junior I.S. is where the project topic is identified and ideas are developed. In some cases this results in a project proposal which is revised based on comment. The development of writing skills begins with First Year Seminar and continues in a writing intensive course that must be completed prior to beginning Junior Independent Study.

Resources

The Copeland Fund for Independent Study was created in 1995. In 2011-12 the fund provided \$90,000 in funding to seniors to support their projects. The process involves writing a proposal which is reviewed by a committee of faculty and is highly competitive.

Seniors are eligible to apply for library study carrels which are theirs for the entire senior year. The number of carrels is fewer than the number of seniors and carrels are allocated on a first-come-first-served basis.

All students have access to several support centers (Educational Planning and Advising Center, Writing Center, Learning Center, and Math Center). Seniors frequently use the Writing Center for assistance with their thesis.

In January 2012, the Collaborative Research Environment (CoRE) was opened in Andrews Library. CoRE offers collaborative spaces; presentation practice rooms; advanced technology; and support staff for research, writing, and new media needs. Its objective is to support undergraduate research generally, but it is seen as an important new resource for seniors.

Celebrations/Recognition for Completed Projects

The student submits two bound copies of his or her I.S. thesis to the Registrar by five p.m. on the first Monday after Spring Break. The Registrar reciprocates by giving the student a Tootsie Roll and a numbered black and yellow button that proclaims, "I did it." At five p.m., seniors who have submitted their thesis gather by the arch in Kauke Hall. The Scot pipers begin to play and the Dean for Curriculum and Academic Engagement and the pipe band lead the annual I.S. parade through the Kauke arch (in the opposite direction through which they walked as first years) and around campus.

On a Friday in late April classes are cancelled to hold the Senior Research Symposium during which seniors share their Senior I.S. with the campus community and general public through presentations, posters, and exhibits.

Each year the *Wooster Magazine* devotes an issue to that year's I.S. projects. The College web page features short videos of students describing their I.S. experience, and Andrews Library has a public meeting space with a large touchscreen monitor with a similar set of videos. This location is part of the tour given by the Office of Admissions to prospective students.

Formal Assessment Structures for Evaluation of the Capstone Program

There has been no formal assessment of Independent Study in recent memory and there is no effort to use I.S. to assess general institutional learning objectives, including the recently adopted Graduate Qualities. Most departments and programs that offer I.S. use it as their direct measure of assessment of learning in the major or minor. The Teagle Capstone Project undertaken from 2009 to 2013 has been the first formal assessment of I.S. in decades.

SUMMARY OF CAPSTONE FEATURES

The following notes and Table 1 highlight features of the four programs.

- A universal capstone requirement. All students are required to complete a capstone.
- A long history of capstone programs. For Allegheny, capstones date back to 1821. Washington's and Wooster's programs date to the 1940s. Augustana is the exception, implementing its program in 2008.
- Generally similar views of the capstone's objectives. These focus on a culminating, sustained, independent act of research or inquiry, centered in the student's major(s). There is an emphasis on critical thinking and communication skills. Although a major thesis or paper is a common requirement in many departments, one school has a universal "substantial written work" requirement and two schools require an oral defense. Unique to Augustana is an explicit "reflection" requirement on the meaning of the capstone for society.
- A high level of departmental control of the capstone. None of the institutions has a designated central faculty or administrative committee for program oversight. Since

capstones center on practice of scholarship in the discipline, this approach recognizes the need to adapt policies to disciplinary approaches and standards. However, this may lead to some incoherence in approaches to such common concerns as capstone rationale and expectations, mentor training, faculty workload credit, and program assessment.

- Variation in the types of capstones, acknowledging differences in disciplinary approaches to research or knowledge production. For example, capstones in the sciences commonly include laboratory or field work research, capstones in the arts may include creative expression, pre-professional capstones may include internships, or, in the case of education, student teaching.
- A standardized formula for faculty teaching credit. The exception is Augustana, which varies the formula by department. For the other three institutions, the formulas are standardized across campus providing roughly one course release for supervising 11-12 capstone students for a standard course (Wooster's capstones count as two courses).
- No formal institution-wide mentor handbook or training program. Training is informal and new faculty members are often initiated through sitting in on capstone student-mentor meetings, attending student oral defenses, and being a second reader.
- No institution-wide capstone manual for students. This may be a consequence of departmental variation in the capstones, although the general objectives would seem to be a common theme that might warrant an institutional explication. At Wooster, each department is required to provide rising seniors with a manual of policies and procedures.
- Capstone specific preparatory experiences. All institutions recognize the need for curricular elements that prepare students for the capstone. Critical thinking skills and communication skills in writing and oral presentation are developed through general education and courses within the major. Most departments have one or more courses specifically designed as preparation for the capstone that cover such things as research methods, writing in the discipline, and may include development of the capstone proposal or identification of the capstone project topic.
- Financial support for individual capstones. Although the amounts vary widely, all institutions have some provisions for allocating funds for individual students to support capstone needs such as for supplies, materials, equipment, and travel.
- Double major policies. Policies on capstones for double majors vary considerably. Double majors at Allegheny generally are expected to complete a single integrative capstone, while at Washington and Wooster double majors do a single combined capstone if a suitable project can be found. This is typical for Wooster and occurs about 50% of the time for Washington. Augustana allows departments to negotiate if a double major must complete capstones in both departments or if one department will waive their requirement; integrated capstones are possible, but not the general rule.
- Rubrics are commonly used by departments to evaluate the capstone "product."
- Assignment of mentors generally accommodates student preferences and the need to balance faculty workload.
- Determination of the capstone topic is typically either done by the student or negotiated between the student and mentor.

Institution:	Allegheny	Augustana	Washington	Wooster
Capstone Title (Informal)	Senior Comprehensive Project (SCP)	Senior Inquiry (SI)	Senior Capstone Experience (SCE)	Independent Study (IS)
Summary Description	A sustained independent act of inquiry or creativity consistent, in methodology and focus, with the nature of such work in that student's academic major. All include a substantial written component and all conclude with a student's oral defense or oral presentation. Nature of projects largely determined by departments.	Culminating project of synthesis, analysis, and reflection.	Project of active learning within the major	Junior year IS plus a two-course senior year IS. Seniors work individually with an advisor on a topic agreed on between the student and advisor, culminating in a thesis or creative project, and defended in an oral presentation. All students must submit their project by the same date. Departments have considerable latitude in the implementation (types of IS, selection of topic and mentor, etc.).
Origin and History	Present SCP format since 1942; some kind of capstone since 1821	SI designed in 2005-6, phased in by departments in 2008-11	A form of senior capstone has been a requirement since 1959. Previously a thesis or comprehensive exam, and called "senior obligation", it has been the SCE since 2006-07.	Established as a universal requirement in 1944 under a philosophy that the most effective learning occurs through the independent effort of the student; that personal development is more than acquiring subject matter knowledge; and, that grappling with the basic problems of scholarship gives the student the confidence and abilities necessary for lifelong learning.

Institution:	Allegheny	Augustana	Washington	Wooster
Purpose/ Objective	Put into independent practice the analytic, creative, and expressive habits cultivated in their major field(s); integrate discipline-specific knowledge with communication and research skills	Substantial in meaning, communicative of discoveries, reflective; with a meaningful mentor relationship	Integrate knowledge and skills to produce sense of mastery and intellectual accomplishment	The culmination of a four-year academic journey and a framework for thinking and inquiry that brings cohesion to the curriculum. Development of engaged and independent learners and the capacity for individual inquiry. Creation of a body of scholarly and/or creative work that is generated independently by the student using the tools and theories of a discipline and that advance or otherwise contribute to a field of study. Moving students from studying in a discipline to practicing in a discipline.
Project Types	Emulates practice of discipline. Laboratory experimentation guided by hypothesis; social science projects do quantitative or theory-based research; humanities projects involve interpretive arguments about primary documents, informed by second-source research, or they are creative works.	No institutional requirement; determined by needs of department curriculum. Example types include traditional research, literature reviews, creative projects, internships, and student teaching.	Varies by department. Types include: traditional thesis (all Departments offer this as an option), Visual thesis (Art), curating thesis (Art), comprehensive exams (Art, Biology, Economics, English, Modern Languages, drama Production thesis (directing, performance or design) playwriting thesis, solo recital (Music), extended composition (Music), lecture recital (Music), programming project (Computer Science), strategic analysis of a firm (Business Management), experiential (Business Management), experimental capstone (Biology, Chemistry, Psychology).	Varies. Examples: Psychology - data gathering project with clear manipulation of at least one variable; Physics - extending knowledge by experiment, simulation, or theory; English - literary analysis or creative works (short stories, poems, novella, film studies, news writing...); Theatre - thesis or based on acting, directing, stage management, play writing, ...

Institution:	Allegheny	Augustana	Washington	Wooster
General Requirements /Expectations	Projects must include a substantial written work and an oral defense. Other expectations vary by department. Most departments have an evaluation rubric.	Varies by department. The reflective component requires a reflective consideration of one or more of the following: the nature of knowledge and inquiry; self-awareness and connection with others; the relationship of individuals to a community.	Students should demonstrate the ability to think critically and to engage in a project of active learning in their major field of studies. They are expected to demonstrate student initiative, significant preparatory work, active inquiry, integration of acquired knowledge and skills, and culmination of previous academic work	Content criteria - the significance of the subject for personal intellectual development, the progress of professional understanding, and the needs of society. Manageability of the topic is also an essential consideration. Method - development of a plan with an appropriate logic, design, or conception. Form - communication of what has been discovered or developed through exposition or creative expression. An oral defense.
Grading Policies	Letter grade; passing required for graduation. Grades determined by the project director and second reader after the oral defense. Some departments consider these grades provisional pending a departmental review to "norm" the grades. Most departments have rubrics.	Mostly letter grades. Varies by department.	Set by department. Some honors, pass, fail or pass and fail; others regular grades; passing required for graduation. Project due on last day of classes, senior year.	No Credit, Satisfactory, Good, or Honors. Grades based on the work accomplished during each of the semesters, the quality of the completed thesis, and the oral defense of the thesis. Grade jointly assigned by first and second reader. Some departments hold a meeting to discuss assignment of I.S. grades. Many departments have evaluation rubrics.
Topic Selection Methods	Varies by department. Examples: students approach and negotiate with faculty whose expertise matches the focus the student would like to take; students choose from categories of topics and linked mentors presented at open houses, on web sites; topics determined as extensions of a junior or senior seminar. Almost all departments require a project proposal.	Varies from individually negotiated to student enrollment in a topical seminar from with the topic is derivative and the mentor is the seminar instructor.	Most topics are negotiated between the student and mentor, and is usually allied with the mentor's interests and expertise.	Topic selection is student-driven and negotiated with the advisor, but methods vary by department. All departments have a handbook covering the process and many have meetings where faculty share their interests and suggest ideas for IS topics. Sometimes done during Junior IS.

Institution:	Allegheny	Augustana	Washington	Wooster
Mentor Selection Methods	Varies by department and conjoined with topic selected (see above). Most restrictive are projects extending a seminar, where the mentor is the seminar instructor. Second readers are mostly assigned by department chairs based on expertise and workload distribution.	Varies by department from individual selection determined by the instructor scheduled to a simultaneous seminar.	In order of most frequent: chosen by students, negotiated, or assigned by departments.	Varies by department. Considerations include student and advisor preferences, the student's topic, and the need to distribute advising load. In some departments students submit a list of ordered preferences and an attempt is made to match. Some use a first-come first-served approach. Some use Junior IS to pair students and faculty.
Student Credit Hours (semester Hours)	4-8 credit hours. Most common is 6 credits spanning two terms with a 2-credit preliminary course in which students do research and develop their project proposal followed by the four-credit project itself.	With exceptions, 3 to 9 credit hours, with 3 most usual.	4 credit hours	4 credit Junior IS over one semester plus 8 credit Senior IS over two semesters
Faculty Teaching Credits	Point system. 4 points per student: 3 for the project director, 1 for the second reader. With double-major projects, the capstone advisors from each major receive two points each (and that usually constitutes the faculty board for the project). A course release is given for 44 points, so 11 senior projects are roughly equivalent to a course. Points can be banked, but only one release can be used in any term.	Varies by department according to formulas negotiated with the dean.	One course release for every 12 capstones supervised. Can be banked. Faculty can opt for payment on the same basis as a course overload, the most common option due to a shortage of qualified adjuncts to cover overloads.	Faculty teach 5.5 teaching credits/year. Faculty receive one course release for advising five IS students for the two terms. Credits can be "banked."

Institution:	Allegheny	Augustana	Washington	Wooster
Expectations for Mentors	No formal expectations or requirements have been enunciated, assuming same expectations as for classroom teaching. No mentor handbook. Training is informal and collegial. New faculty don't mentor the first year, often begin by attending oral presentations.	No explicit expectations.	No formal expectations.	Help identify topic; meet regularly with the student (3/4 -1 hour/week, but varies greatly by dept.); assist with thesis editing; provide a written evaluation of the work submitted
Student Preparation	Junior seminar; approved proposal	General education courses, earlier department course(s), research methods courses.	Most departments offer a course specifically designed to prepare students for the capstone. Depending upon the department, these preparatory courses include Junior Seminars, Senior Seminars, and various research methods courses. Virtually all of these preparatory courses involved learning methods useful for the SCE, determining the SCE topic, developing a capstone proposal, starting work on the SCE, and refining discipline specific communication skills. About half included assigning students to SCE mentors, and some prepared students for a comprehensive exam.	The general education requirements and courses taken in the student's major are intended to prepare the student for Senior Independent Study by developing disciplinary expertise, critical and creative thinking skills, and communication skills. The development of writing skills begins with First Year Seminar and continues in a writing intensive course that must be completed prior to beginning Junior Independent Study. Most departments require a one semester Junior IS course, often a research methods course.
Institutional Administration	No central administrative or faculty group. Policies and administration under departmental control, except for faculty workload credit system.	No central administrative or faculty group. Policies and administration under departmental control.	No central committee. Administered almost entirely by departments.	No central committee beyond Educational Policies Committee. Departmental latitude within general framework. No formal assessment has been done recently , other than through this Teagle Grant

Institution:	Allegheny	Augustana	Washington	Wooster
Double Majors	Project nature negotiated among student and advisor from each department, and are expected to be integrative. Credit hours count once on transcript but towards each department's requirements separately. Deadlines are set by the department the student identifies as the primary major.	Policies vary by department. Integrative capstones are not the general rule. Some departments require a capstone in their department and the student will do two capstones. Others may waive the requirement in deference to another department, based on the student's preference.	Double majors complete a single, combined capstone about 50% of the time. Whether the capstone is combined or separate, each faculty mentor receives full credit (1/12) for that student, but the student receives only one course credit.	A student is required to complete all the I.S. requirements in each of his/her majors. Typically a double major will find a topic that satisfies the requirements of both departments and produce a single thesis. In these cases, each department will provide an advisor. The student registers for the first semester of Senior I.S. in one of the departments, and for the second semester in the other department.
Special Resources	Funds distributed from the Provost's office are designated to support senior projects. The Center for Experiential Learning can help fund students' travel to conferences in which they present research undertaken in their senior projects. A "Senior Research Fund" underwrites awards up to \$500.	An "Augie Choice" fund incorporated in tuition charges serves as a \$2000 personal account that students may draw on for senior projects, among other approved opportunities such as study abroad.	While no funding sources are specifically devoted to SCE, some departments provide funding support for students, and some receive support from fellowships.	The "Copeland Fund" provides about \$90,000 annually to support individual projects, granted by competitive proposal review. Library study carrels. Support centers for writing, math, advising. Collaborative Research Environment center - collaborative spaces, presentation practice rooms, advanced technology, support staff for research, writing and new media.
Celebrations/ Recognition of Completed Projects	Electronic archiving of projects in "D-Space." Invited presentations at a project celebration. Departmental celebrations. Currently working on a reserved calendar day at the end of the school year for presentations.	An all-day campus-wide "Celebration of Learning", is held on a Saturday in spring, and gives students an opportunity to present their projects as oral presentations or via posters.	No college-wide celebration, but a number of departments host events. All students submit their capstones to the college library's online database.	All projects due on the Monday after spring break. A celebratory parade of seniors who have submitted their project is held that day, and "I did it" buttons are worn. Classes are canceled in late spring for a "Senior Research Symposium" with presentations, posters and exhibits. <i>Wooster Magazine</i> devotes an issue to projects. College web page features short videos of students explaining projects.

DEPARTMENT POLICIES AND ADMINISTRATION SURVEY RESULTS

This survey was completed by 108 departments/programs across the four campuses. Respondents were fairly evenly distributed by school and the three major academic divisions (humanities, natural sciences, and social sciences).

Highlights:

- 67% of departments have a course specifically designed to prepare the students for their capstone.
- Departments reported this course covered the following items:

Please describe to what extent the following items are covered in this preparatory course:	% not at all/ very little	% to a great extent	Mean (4 pt scale)
Refining discipline-specific communication skills	4%	70%	3.19
Learning methods useful for the senior capstone	4%	65%	3.80
Determining the topic of the senior capstone	17%	59%	3.59
Creating a senior capstone proposal	24%	54%	3.60
Assigning students to senior capstone advisors	49%	39%	2.68
Starting work on the senior capstone	37%	27%	3.34
Preparation for a comprehensive exam	94%	3%	2.37

- 75% of the programs reporting that their capstone had a fixed number of credit hours indicated it was 4 semester credit hours or fewer. 8 semester hours is standard at The College of Wooster
- The mentoring workload is distributed among faculty mostly by a combination of student requests and a need to balance workload:

What best describes how the capstone mentoring workload is distributed among department faculty?	Valid Percent
by student requests for individual faculty	34.4
by assignment of faculty to a scheduled capstone seminar or course	21.1
by a department policy that balances loads	20.0
other	24.4
Total	100

- The most common practice for double majors is for the student to do a single combined capstone:

How often does a student in your department who is a double major do a single combined capstone?	Valid Percent
1 rarely/never	19.3
2 occasionally	21.6
3 about half the time	14.8
4 usually	34.1
5 always	10.2

- About half of departments report using traditional letter grades or letter grades plus honors:

What grading system is used for the capstone? Check all that apply.	% yes
Pass/Fail	5.6
Pass/Fail/Honors	11.1
Honors/Good/Satisfactory/No Credit	22.2
Traditional letter grades	45.4
Traditional letter grades/honors	4.6
Other (please specify)	

- Over three quarters of departments involve more than just the mentor in assigning the grade. Among those who selected “Other” almost all indicated that the reader(s) recommended a grade, with the grades for the department’s capstones then reviewed by the department.

Who reviews the capstone for grading? Check all that apply.	% yes
Mentor only	22.2
Mentor and second reader	46.3
Committee of department faculty	7.4
Committee of department and external faculty	0
The entire department	12
Other	13

- Using a rubric to determine the grade is a reported practice by 47% of departments, while 53% do not use a rubric.
- Departments report funding to support student capstone projects varies from none to providing a fixed amount. Some report access to an endowed fund or other individual fund. 37% of departments report no students receive funding, 16% report all students receive funding.
- In response to “Please indicate any areas where you think support for your department’s capstones is strong or inadequate”, 10 departments listed both a strong and an inadequate area, 14 only a strong area, and 27 only an inadequate area. The predominating sense is that departments are in need of additional resources to support their capstone programs.
- The median reported percentage of students who do not pass the department’s capstone was 2%.
- The median reported percentage of students who do not graduate due to failure to complete the department’s capstone was 1%.
- The median reported percentage of students who had an undergraduate research experience outside of the context of a classroom course (i.e. excluding independent study) was 20%.

- The median estimate for the percentage of students who present their capstone work at a professional or undergraduate conference was 10%.
- The median estimate for the percentage of students who publish their capstone work in professional journals was 2%.

CAPSTONE DESCRIPTION SURVEY RESULTS

Many departments offer alternative types of capstones, and departments/programs were asked to complete a descriptive survey for each distinct type of capstone they offered. Multiple submissions were possible from a single department/program. Respondents were fairly evenly distributed by school and the three major academic divisions (humanities, natural sciences, and social sciences). 105 responses were received.

Highlights:

- Below are the results of a series of questions about the importance of various capstone characteristics, in descending order of the percent “essential.” These are the overall results, and one would expect significant variation if the results were broken down by academic division.

Please indicate the degree of importance each of the following has as part of capstones of this type:	% not imp	% essential	Mean (4 pt scale)
Production of a written thesis or substantial paper	2.1%	86.6%	3.80
An oral examination of the project	6.0%	78.3%	3.59
A literature search and review	1.9%	72.8%	3.60
An oral presentation of project progress or results	8.9%	64.4%	3.34
A reflective analysis concerning the project (e.g., its value, lessons learned, contribution to the discipline or to self-knowledge, etc.)	9.3%	54.7%	3.19
Generation of data through direct measurement (e.g. through experiments, observation, questionnaires, interviews, etc.)	25.3%	42.7%	2.68
Creation of or contribution to an artistic performance or product (music, art, theater, literary work ...)	34.9%	32.6%	2.37
Use of other library services (e.g. library instruction, reference librarian assistance, special collections)	19.6%	28.4%	2.63
A poster presentation of project results	38.2%	27.9%	2.25
Laboratory experimentation	32.7%	26.9%	2.40
Statistical analysis of data	20.5%	21.9%	2.40
Clinical or practicum experiences	51.4%	21.6%	2.03
A written examination	71.0%	19.4%	1.74
Collaboration with other students	35.4%	13.4%	2.04
Field study (e.g. research or projects carried out on location)	30.6%	11.3%	2.05
Internship experiences	60.0%	8.0%	1.62
Civic engagement or service learning experiences	52.7%	7.3%	1.71
Questionnaire construction and analysis	49.1%	5.7%	1.68

The most universal features of capstones that emerged were a literature search/analysis and communicated products in the form of a written thesis or substantial paper and an oral presentation or defense. Some sort of reflection on the meaning of the project seems to also be common. Many of the other features, such as statistical work, have lower overall means because they do not apply equally in all disciplines. This variation is shown in the means by division, as included in the table.

- 90% of respondents indicated the mentor was assigned prior to the beginning of the senior year, 10% after the senior capstone has begun.
- Pairing of the student and mentor most frequently, but not always, involves student input or choice:

How is a student typically paired with a mentor for the capstone?	Valid Percent
other	7.7
by enrolling in a course (e.g. capstone seminar) with a departmentally assigned instructor	12.5
negotiated between student and mentor	33.7
assigned by the department using student preferences	40.4
assigned by the department not using student preferences	5.8
Total	100.0

- The predominant mentoring style is one-on-one mentoring:

If mentors supervise multiple students at one time, how is the mentoring typically structured (select the best option):	Valid Percent
using one-on-one mentoring only	41.0
primarily using one-on-one mentoring, with less frequent group meetings	29.0
primarily using group meetings (e.g. a seminar), with incidental individual mentoring	11.0
primarily using meetings (e.g. seminar) but with significant structured individual mentoring	8.0
varies by faculty member	12.0
Total	101.0

- 88% of respondents report that the student usually or always is assigned to the mentor of their first choice. The most common reasons reported for not giving the first choice are to balance faculty workloads and to better match faculty interests or expertise.

- The topic of the capstone is most frequently negotiated between the student and mentor (53%) or by student selection (31%).

Typically how is the capstone topic determined?	Valid Percent
other	11.7
student selection	31.1
mentor selection	3.9
negotiated between student and mentor	53.4
Total	100.0

- Capstone topics are generally aligned with the mentors *interest or expertise*, but not generally with the mentor’s creative, scholarly or research *projects*:

How often are students’ projects allied with faculty mentors’ creative, scholarly, or research projects?	Valid Percent
rarely/never	19.6
occasionally	41.2
about half the time	18.6
usually	17.6
always	2.9
Total	100.0

How often are student’s projects allied with faculty mentors’ interests or expertise?	Valid Percent
rarely/never	2.0
occasionally	19.6
about half the time	15.7
usually	52.9
always	9.8
Total	100.0

HIGHLIGHTS OF CAPSTONE PRACTICES FROM THE STUDENT AND MENTOR SURVEYS

The following items highlight views of the capstone experience relating to institutional practices as seen by both students and mentors, as gleaned from our surveys and institutional data.

- **Capstone grades.** Most grading for capstones in our database was done with traditional letter grades alone (59%) or with an honors option (+4%). A pass/fail or pass/fail/honors grading system was used for 16% of the capstones and an “honors/ good/ satisfactory /no credit” system for 25%. 25% of grades were assigned by the mentor alone, but for 56% a second reader was also used. For 14%, the department assigned the grade. Schools using a second reader note its value in maintaining uniformity of standards, as a backup for the mentor, and as a training experience for new faculty.

Overall, capstone grading averaged about the same as for regular courses, but with significant variation by school and division. The average capstone grade was 3.25 (B+)

which is about the same as the average pre-capstone college GPA (3.22). Female students had a higher average capstone grade than males, 3.33 versus 3.12, but in line with pre-capstone GPAs of 3.31 and 3.08, respectively. Natural Science students had the highest average capstone grade, 3.34 and the biggest jump from the pre-capstone GPA, 3.24. Similarly, students in the lower GPA range scored a lower average capstone grade than students in the highest GPA range, but again, these values are about the same as their GPA averages pre- and after the post-capstone.

- **Preparation from coursework.** Not surprisingly on the post-capstone survey, students considered courses in the major or minor, including a junior or senior seminar, as the most important preparation, $m=3.46$ on a 4-point scale. Surprisingly, however, courses outside the major, which includes general education courses, are rated markedly low, $m=2.10$, just above volunteer experiences, $m=2.06$, and much lower than general non-academic interests/experiences, $m=2.74$. The results are consistent with our general result that, in practice, the capstone experience is most typically an in-depth experience in a particular discipline (as opposed to inter-disciplinary), and consequently, relies mostly on strong disciplinary preparation. Students in the Natural Sciences were the least likely to find courses outside the major/minor useful (1.95) and the most likely to find courses in the major/minor to be useful (3.52).
- **Preparation from prior research experience.** The schools provide extensive pre-capstone research opportunities. 78% of respondents indicated they had experienced a course-embedded research project prior to their capstone (with almost equal participation across the three academic divisions), 41% had completed an independent study course/project and 24% had completed a summer research project. Students in the Natural Science students were most likely to have had a summer research experience of greater than four weeks and to have been a research assistant during the academic year. Students in the Humanities were the least likely to have had these experiences.
- **Topic selection.** Practices on topic selection have an impact on student engagement with the capstone, the goal being to find a topic that the student has an interest in and can “own.” Positive correlations were found between the extent of involvement in originating or developing the capstone topic and student motivation and engagement, use of academic skills during the capstone, skill development, and having a successful capstone. In practice, on five point scales, students reported being relatively happy with the process used for selecting their topic ($m=4.05$), and with the actual topic. They rated their enthusiasm for the topic at the beginning of the capstone with a mean of 4.21. Enthusiasm dropped modestly, however, by the end of the capstone to a mean of 4.09. Negative comments about topic selection were almost entirely about the situation where topics were restricted to the specialty of a concurrent capstone seminar.
- **Students’ views of mentors.** The relationship with the mentor emerged as a crucial part of the capstone experience, and most students were highly satisfied with their relationship with their mentor. Again, on a five point scale, a list of items about the student/mentor relationship showed generally high marks for the mentor’s rapport with the student, including being interested in the project ($m=4.44$), encouraging the

student's independence (m=4.49), and being comfortable to work with (m=4.47). In what seems to be an inconsistency, the mean for "my mentor effectively guided me through the capstone", m=4.19, was lower than all the related specific guidance items, such as sufficient feedback (m=4.29) and useful feedback (m=4.39). (Perhaps there is some important aspect of mentoring that was missed in our survey that contributes to this discrepancy. Or, it may be that students were simply reacting negatively to the "guided me through" portion of the statement. The capstone is intended to be an independent project, and while students may be happy to admit to receiving a great deal of assistance from their mentors, they might be less willing to admit to being "guided" by them. Nonetheless, the overall results seem to indicate students perceive a high level of mentoring ability on the part of faculty.) On the cautionary side, student comments suggest a negative experience with the mentor occurs for an estimated 11% of capstones. These negative comments focused on giving poor or untimely feedback, not being helpful or available, or missed meetings.

- Mentors' self-ratings.** Mentors rate their own performance highly. They thought they gave the student sufficient access (m=4.64) and useful advice (m=4.55), but were less confident that they provided helpful subject matter expertise (m=4.30) or effectively guided the student through the capstone (m=4.28). Although the issue of faculty workload for the capstones arose in several focus groups, it was mentioned rarely in the mentor survey comments, suggesting that mentors feel they are, in general, performing well despite workload concerns. Much of the workload concern may relate to equitable treatment across departments and as credited in load compared to regular courses.
- Student time with mentors.** Students report an average of 2.86 hours per week interacting with their mentor in individual or group meetings, and working an average of 14.1 hours per week on *all* aspects of the capstone. On average, students in the Natural Sciences report meeting for an hour more per week than students in the Social Sciences and Humanities. Lower GPA students report meeting with the mentor for an hour more per week than students in the medium and higher GPA ranges, but spending approximately the same amount of time per week as students in the other GPA ranges.
- Preparatory course features.** For capstones where the department indicated there was a preparatory course, the means shown in the table below indicate the extent various items were covered (on a 4-point scale from "not at all" to "a great extent"):

Please describe to what extent the following items are covered in this preparatory course:	
Refining discipline-specific communication skills	3.54
Learning methods useful for the senior capstone	3.51
Determining the topic for the senior capstone	3.31
Creating a senior capstone proposal	3.27
Starting work on the senior capstone	2.70
Assigning students to senior capstone advisors	2.53
Preparation for a comprehensive exam	1.15

Thus three frequently occurring features of a capstone-specific preparatory course are learning to write or communicate in the style of the discipline, learning capstone-specific research/inquiry methods, and deriving a capstone topic and developing a proposal. In retrospect, there should have been questions about capstone project management, as student comments reveal this as an area where they encounter difficulty (and growth) during the capstone.

SECTION 4: PROJECT FINDINGS

PROJECT METHODOLOGY: DESCRIPTION AND LIMITATIONS

The project used a mixed methodology approach to collecting data that would provide answers to the questions identified in the Introduction. In the project's first phase surveys were used to gather mostly quantitative summary measures, pre- and post-capstone from the student and the student's mentor, supplemented by textual analysis of responses to open-ended questions about the students' and mentors' capstone experiences. These findings were used to guide the more in-depth qualitative study of the project's second phase, which consisted of focus groups with students, faculty and others involved with our capstone programs. Alumni two, five, and ten years out were invited to participate in the HEDS Alumni Survey which included a set of questions specific to this project.

Description of Instruments Used and Data Collected

The registrar offices on each campus provided bio-demographic data (age, gender, ethnicity, high school GPA, major and major GPA, etc.) on each senior graduating in 2010 and 2011. Similar data were collected on faculty mentors. These two sets of data formed the foundation for the project database to which survey responses from seniors and advisors were added. Each student and mentor was given a unique participant identifier and each capstone was given a unique capstone identifier. Students with a double major had a unique capstone identifier for each major. The instruments briefly described below can be found in Appendix B.

Senior Pre-Capstone Survey – includes items asking about personal attitudes, self-perception of academic ability, characteristics of academic work done so far, goals following graduation, and hopes and concerns about the forthcoming capstone project. The survey was completed by students at the end of their junior year or at the very beginning of the capstone in their senior year.

Faculty Pre-Capstone Report – The faculty report asks for an assessment of the rising senior with respect to developmental and educational outcomes important to his/her capstone course specifically and to his/her undergraduate education generally. This report was completed prior to or near the beginning of the capstone by a member of the faculty who was familiar with the student's earlier work as an undergraduate. Ideally this was also the faculty member who completed the post-capstone report, but this did not happen for all capstones.

Senior Post-Capstone Survey – The post-capstone survey repeats the items from the Senior Pre-Capstone Survey, providing a before/after picture, and included several items specific to the student's capstone experience. The survey was taken shortly after completion of the capstone and prior to graduation.

Faculty Post-Capstone Report – The post-capstone report repeats the items from the Faculty Pre-Capstone Report and included several items specific to the student's and mentor's capstone experience. The report was completed by the capstone mentor shortly after the last component of the capstone (typically an oral defense) was completed.

Departmental Capstone Description Inventory and Department Capstone Description – One outcome of the planning grant was the creation of an Institutional Capstone Inventory whose purpose was to help identify the defining characteristics of our capstones as well as the resources our schools invest in them. Although this initial inventory was useful, it became clear that there is variation across departments in how the capstone is realized, as well as variation among types of capstones within some departments. It was important to understand this variation. The result has been the development of two instruments that gather information at these levels: a Capstone Policies Inventory and a Department Capstone Description.

Alumni Survey – The four colleges in this study participated in the 2009-10 Higher Education Data Sharing (HEDS) Alumni Survey to investigate alumni reports of the impact of the senior capstone experience on their post-graduate personal and professional lives, and their retrospective thoughts on the nature and value of the capstone experience. Supplemental questions focusing on capstone experiences were added to the standard HEDS Alumni Survey for this purpose. The graduating class cohorts of 2007, 2004, and 1999 were surveyed to represent different post-graduate life/career stages - two, five, and ten years out.

Focus groups – Each campus held six focus groups: three senior focus groups with representation by gender, GPA, and division; two faculty focus groups – one junior faculty and one senior faculty with representation by gender and across the divisions; and one focus group for support departments – writing center, learning center, instructional technology, library, and so on. The focus groups were conducted by Teagle Assessment Scholars.

Method of Analysis for Quantitative Data

Quantitative analysis was done based on the project's database of individual capstones from the years 2009/10 and 2010/11, which includes selected student bio-demographic data, the student's pre- and post-capstone survey responses, the paired pre-capstone report from a faculty member familiar with the student's pre-capstone academic performance (ideally the capstone mentor), the mentor's post-capstone report, and the matched data describing the type of capstone course taken by the student from the departmental policies and capstone type surveys. Altogether the database has the records for 2,843 distinct capstones, each with 636 data fields.

Primary statistical analysis was done using SPSS V18. Unless otherwise indicated, statistical significance of differences was determined using two-tailed t-tests and will be noted only if at $p \leq .05$. Levels in tables are noted by asterisks: * $p \leq 0.05$, ** $p \leq .01$, *** $p \leq .001$. To add a measure of practical significance, the tables of pre/post capstone differences also include an "effect size" measure which is computed as the mean of the differences divided by their standard deviation, a computation that scales the magnitude of the change relative to a uniform total variation measure, somewhat analogous to using percentages. An empirical comparison showed this computational method results in values close to the common method of comparing two means by dividing the mean difference by the pooled standard deviation. The simpler formula was used to avoid a lot of unwieldy computations given the number of subgroup breakdowns. In our definition, the difference in the means is computed as the post-capstone mean minus the pre-capstone mean. A positive effect size, therefore, indicates an

increase (generally growth or improvement) during the capstone, and a negative change indicates a decline. Following Cohen (1988), a general interpretation of the standard effect size is that effects of about .2 might be considered “small,” .5 “medium,” and .8 “large.” Noting, however, that our surveys are similar to the NSSE surveys, and actually used several of their questions (with permission), we chose to use NSSE’s characterization of effect sizes: .1 small, 0.3 medium, 0.5 large. (See http://nsse.iub.edu/pdf/effect_size_guide.pdf).

The subgroups of most interest in considering the project’s research questions and that most of the data tables include are: students overall and students from each school; the three academic divisions (NS=Natural Sciences; SS=Social Sciences or SS+=SS with business administration and teacher education included; and HUM=Humanities, with languages, literature, and arts included); three college GPA groups (L = “<=2.99,” M = “3.0 to 3.49,” and H = “>=3.5”); and by gender.

Note that the Ns in some tables may vary for individual data fields because of missing values. For instance, a question may have gone unanswered or “not applicable” was selected.

Scales

Given the large number of items in the surveys, factor analysis was done to reduce the data to a more intelligible set of scales that capture the underlying concepts in the surveys and help smooth out the data, reducing some of the “noise” in the responses. Factor analysis of the pre- and post-surveys of students and mentors, done separately for each survey, resulted in a set of scales that combine highly correlated items (see Appendix C). The scales are themselves a valuable outcome of the study that may be useful to others doing subsequent research or for developing assessment instruments.

Most of the scales are from items repeated in both the pre- and post-capstone surveys. The only scale developed from just pre-capstone items, ExpectGoodCapstone, describes a combination of expectations: how much the capstone will help students develop academic skills, prepare them for graduate school or a job, help them understand their own interests and skills better, and engage and challenge them. It represents a positive attitude toward the capstone at the beginning and is an important scale with a high correlation with post-capstone ratings of success and development.

Scales from post-capstone items only are retrospective reports concerning preparation for the capstone, the relationship with the mentor, the engagement of the student with the capstone, the student’s ratings of the capstone as personally successful, and its contribution to the student’s development. The capstone preparation questions factored into three scales: preparation in the discipline through coursework (PrepDisc); preparation through volunteer, study abroad, non-academic interests, internships, or courses outside the major (PrepBreadth); and preparation in quantitative methods (PrepQuant). The relationship with the mentor scale (MentorRel) is a composite of 14 separate items with a very high reliability of .959. This reliability indicates the number of items could be reduced while still providing an accurate measure of this construct.

Two special outcomes scales

Of special note are the post-capstone survey contribution to development (PostCapContDev) and post-capstone survey successful experience (PostCapSuccessful) scales, which capture two aspects of how students perceive a successful capstone. PostCapContDev measures a student's perception that the capstone contributed to their development of academic and lifelong learning skills, such as critical thinking, writing, data interpretation, research skills, managing a large project, having confidence in one's abilities, and learning on one's own.

PostCapSuccessful is related, but, as a separate factor, is distinct. It represents a broader perception of the capstone as a contributor to personal development, including intellectual growth, self-understanding, and realization of personal potential post-graduation. It includes a perception that the capstone contributed positively to a student's intellectual growth and interest in ideas; personal growth, attitudes and values; understanding of skills, abilities, and interests; graduate school or career preparation (including clarification of objectives); and a better understanding of the student's discipline and ability to create new knowledge in the discipline. As our two main measures of success, many of our results relate to discovering what leads to the highest or lowest values on these two scales.

Method of Analysis for Qualitative Data

The senior and mentor post-capstone surveys contained four open-ended questions. The general method for analyzing the responses was to deconstruct them into discrete topical coding units, assigning each of these coding units an ID number, and to assign to each comment as many as five coding units, as appropriate.

There are 3,006 capstone records in our survey database, of which 163 are double major capstones for which the student data is replicated for each of the mentors, leaving 2,843 distinct student records. Of these, 1,660 students, 58%, responded to the post-capstone survey, and of those 1,201 (72%) made a comment on at least one of the four open-ended questions.

The use of counting methods raises a general issue of interpretation – how to interpret the counts for an individual coding unit, many of which are low, sometimes just 1 or 2. First, the coding units are fine grained. Second, the questions are very general, were placed at the end of a long survey, and were likely to elicit only one or two distinct ideas each. Indeed, two questions suggested precisely this by asking only for the “most” valuable experience or any “particularly positive or negative” aspect. The average number of coded units per non-blank response ranged from 1.3 to 2.3.

Since the counts for subgroups were unequally sized, the raw counts were augmented by computing percentages before making comparisons among groups.

Limitations of the Data and Analysis

Our goal was to obtain complete survey data for all capstones completed during the years 2009/10 and 2010/11. Non-response bias is a potential concern because for 22% of the capstones no student surveys were obtained and both the pre- and post-survey were completed for a minority, 43%, of the capstones.

Citing the statistically significant differences, $p \leq .05$, two-tailed, the students who completed both pre- and post-surveys, on average, received a higher grade on the capstone, had a higher college GPA both before and after the capstone, had a somewhat higher expected family contribution for college (indicating higher average family incomes), had a higher average ACT (including converted SATs), had a higher average high school percentile, had a higher percentage of females (70% vs. 51%), had a higher average educational level for mothers, and participated in fewer intercollegiate athletic teams during their senior year.

In short, higher achieving students, higher socio-economic-status students, and females tended to respond in higher percentages, a result shared with most student surveys. This, of course, limits our ability to generalize overall means and percentages to all seniors without weighting the results based on sample imbalances. However, for almost all of the analyses the findings take these differences into account by considering separately in the tables and statistical models the student subgroups based on school, GPA level, gender, and academic division. We have excluded separate consideration in the tables of socio-economic subgroups (SES) based on an analysis that SES has little impact on capstone outcomes. Finally, our results based on generally linear modeling (GLM) include school, GPA, gender, and academic division as variables.

The sampling for the alumni survey presents some concerns in interpreting the results. Due to a miscommunication, one institution did not survey the 2007 cohort. Also in the composite results, which are unweighted by institution, not all institutions are represented equally. Finally, sample bias is a potential issue because, as usual, only a minority of alumni responded to the surveys. For the four colleges, the percentage of the graduating classes that responded was approximately 10%, 23%, 16%, and 35%. Females were overrepresented in the respondents, with 63% being female, 37% male.

ANALYSIS OF PRE/POST CHANGE – STUDENT SURVEYS

Because we are interested in changes during the capstone and this is best done with a repeated measures design, the data presented here are based on only the 1,229 capstone records with a matched pre- and post-capstone student survey, supplemented by observations from the qualitative data collected from the open-ended questions asked on the senior and mentor post-capstone surveys. The faculty survey data is based on the same subset of capstones.

The tables in appendices D and E give a high level view of the scales and component questions showing only statistically significant changes with up or down arrows. The small numeral next to the arrows indicates the effect size rounded to the closest 10th. (Following the discussion of methodology above for a suggested interpretation of effect size, the effects corresponding to the numerals would be interpreted as: 1 small, 3 medium, 5 large.)

Although the tables are very helpful in separating out means by school, division, GPA level, and gender, it isn't clear how these interact. To tease this out, references and plots are included below from a series of SPSS GLM models for the pre/post difference scores that included school, academic division, pre-capstone GPA (as a continuous covariate), and the school*division interaction. These generally show that, after controlling for the pre-capstone GPA, there are significant interactions of school and division for many of the scales, particularly

for those with larger effect sizes. The plots elucidate these interactions by showing the estimated marginal means for the predicted difference scores by school and division, with the GPA set at the overall mean value of 3.32. The statistically significant effects are noted in the text. Plots have not been included in the cases where school and/or division did not show differences of statistical significance. The reader should note the scale when reviewing the charts, as it may exaggerate small differences. The connecting lines in the graphs have no significance other than to visually track the points for the same academic divisions. In accord with our agreement on confidentiality, individual schools are identified by a color alias on the plots and in the text.

As is a general concern with pre/post change value added measures, one should consider the possibility that changes are not truly related to the effects from the group category itself (school, discipline, gender, GPA), but influenced by the starting position. This might occur if groups that start high on a measure may encounter a ceiling effect and groups that start low may have greater potential to show gains, perhaps through a remedial effect. Another possibility is that in multiple measures a regression to the mean effect may affect pre/post differences. Comparing the starting values for our scales against the value-added change for our standard student groups leads to a generalization that the data does NOT show apparent effects of these types and, while one can never dismiss this possibility entirely, unless otherwise mentioned below we are taking the significant changes discussed below as genuinely due to the effect of the group(s) indicated.

The statistically significant changes observed for the scales were:

- Scale Increases: Eight student scales (exhibit scholarly skills, need for cognition lite, project management, academic ability self-rating, collaborative skills, independent voice, strive to achieve, and research orientation) and all four faculty scales (communication skills, effective project management, intellectual engagement, and critical thinking skills).
- No change: Civic orientation, status career orientation, and satisfaction with instruction.
- Scale Declines: Higher order cognition, satisfaction with support services, and use of multiple perspectives.

Student Scales that Increased

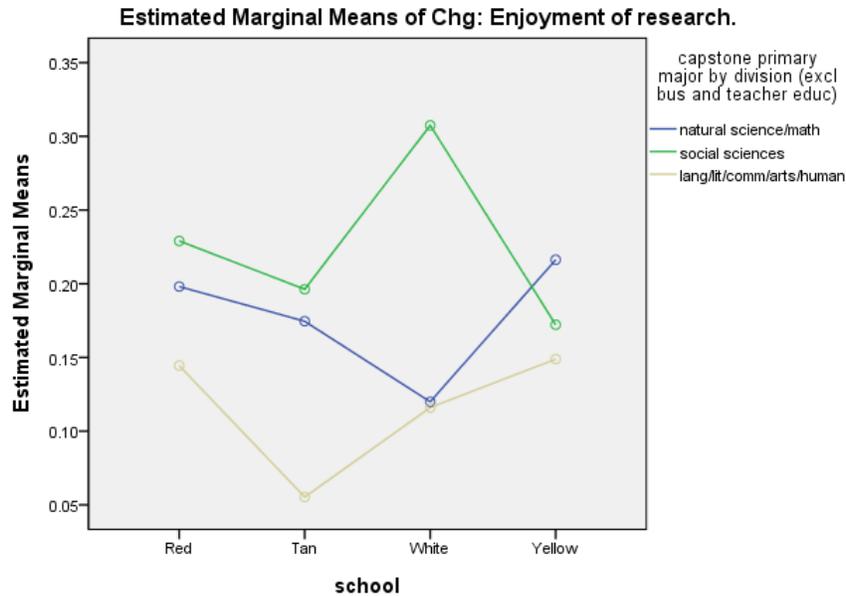
Exhibiting Scholarly Skills (effect size = +.42) and Research Orientation (effect size = +.29)

The combined increase in these scales is evidence that the capstone, as implemented on our campuses, is an effective educational practice. Students report that they performed at a higher level on many critical thinking, research, and communication skills during the capstone than in prior regular courses, and that, on average, they gained in enjoyment of doing research.

These scales increased overall and for all student subgroups. Moreover, there was a statistically significant increase in the mean response for each individual question in both scales. For individual items, the only significant decline observed was among Humanities majors for quantitative reasoning, a result that adds credibility to the validity of student responses. The GLM for exhibiting scholarly skills showed no statistically significant effects at $p < .05$, although school and division were close to the $p < .1$ level.

Research skills and orientation (effect size = +.33)

The GLM for research orientation showed division is significant and suggests the greatest gains for research interest were in the Social Sciences.



Covariates appearing in the model are evaluated at the following values: College GPA - Start of capstone year = 3.3170

In the post-capstone open-ended questions, seniors were asked what aspects of the capstone will be of most value after graduation. Development of research skills accounted for 219 comments (12%). Comments from seniors in the natural and Social Sciences were most likely (15%), with relatively fewer comments from students in the Humanities (9%). There are two related categories: “Valued the research experience” with 6% of comments, and “Increase in valuing work-related attributes of research/projects” with 4% of comments.

Students of all GPA ranges were about equally likely to cite research skills as a benefit.

Understanding knowledge in a broader context and gaining disciplinary knowledge appeared in 113 comments (6%). Based on the comments, gaining disciplinary knowledge does not appear to have the same importance as skill-based gains resulting from the capstone. Similarly, understanding knowledge in a broader context is quite weak as a reported capstone post-graduate impact.

This is consistent with other evidence we have and is disappointing. We believe the capstone is a culminating experience that is intended to bring together valued liberal arts outcomes, but the biggest gains are associated with the skills needed to successfully complete a large project within a discipline. We have hypothesized that in identifying a fairly narrow question to take on, students are focused on the academic background needed for that investigation and haven't the time to sit back and see their work in a larger context.

Rating of Academic Ability (effect size = +.27)

Students' ratings of their abilities in writing, creative and critical thinking, and academic ability in general went up pre- to post-capstone, as did their intellectual self-confidence. An increase in the mean was observed for every school and student type. Looking at the component items for this scale, it seems that the strongest increases may be for the highest GPA group, and for females, but this impression for females was contraindicated by a GLM that added gender and gender*division to the model and showed no significant effect from gender. The original GLM without gender showed no significant effects.

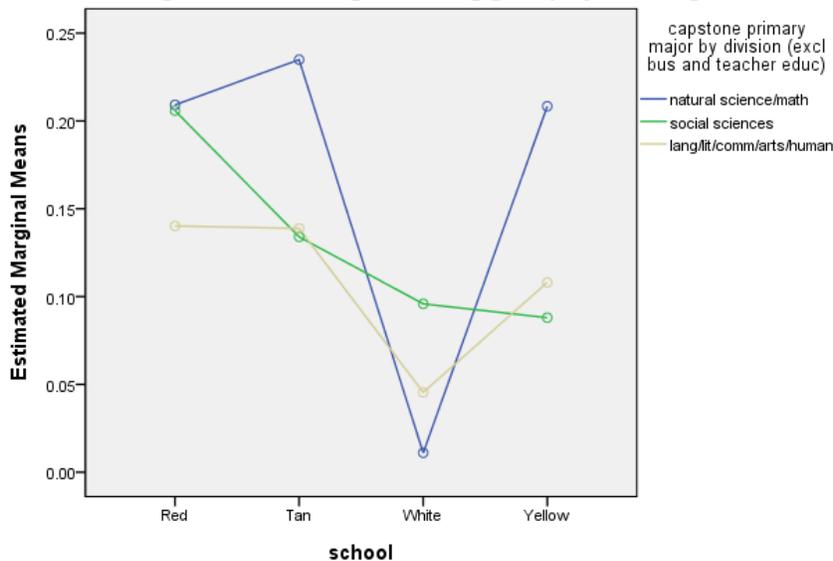
Development of writing and oral communication skills appeared in 234 student comments (12%). 152 were about writing skills and 82 dealt with oral or general communication, many about presentation skills. Of the comments about writing, 43 specifically mentioned the length of the written work as contributing to the student's development, clearly a characteristic prominent in capstones.

Citing improvement in oral and written communication as a benefit was fairly even across all student subgroups.

Project Management (effect size = +.17)

A significant increase was observed for all divisions, GPA level, and for both genders. By school, however, significant increases were found only for the two schools with the most intense capstones in terms of average credit hours and duration, which in one case is always the full senior year. It is likely that achieving significant development of project management skills during the capstone is enhanced by capstone programs that emphasize the scale, challenge, and duration of the projects as well as mentoring styles that foster student independence. The GLM for the change in project management skills showed GPA as significant at $p \leq .05$, and, notably, that students with *lower* GPAs reported *higher* gains in project management skills.

Estimated Marginal Means of Chg: Exhibiting good project management skills.



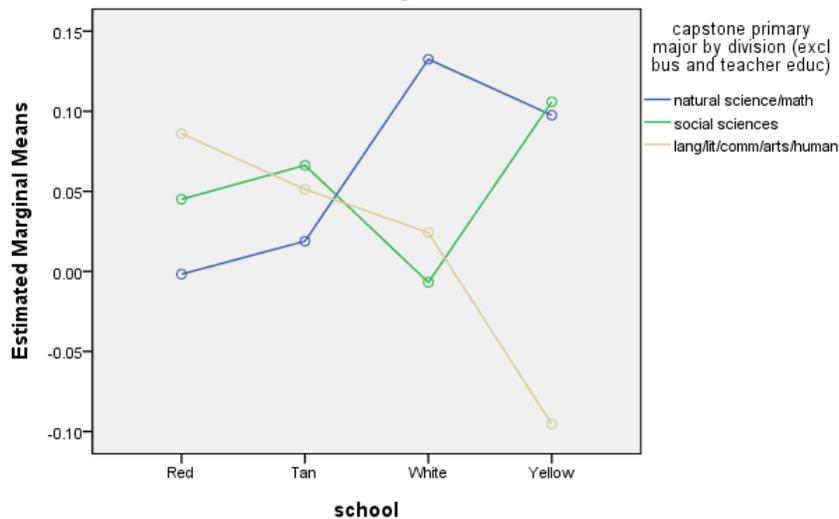
Covariates appearing in the model are evaluated at the following values: College GPA - Start of capstone year = 3.3219

In the student open-ended questions, an increase in project management skills was among the most frequently cited benefit (334 comments, 17%) of the capstone. Several subareas received a significant number of comments: organization, time management, ability to work independently, seeing a significant project through to its completion, working under pressure, and troubleshooting. These characteristics are prominent in (and in scale are unique to) the capstone experience and are apparently new to most students. Students from all academic divisions except professional, which had a lower percentage, were about as likely to cite project management. Project management was also about as likely to be cited by males as females, and slightly more likely to be cited by the lower GPA group. Project management was somewhat more likely to be cited by students from Red, where the capstone is always a full year project, than from students from White or Yellow, and least likely to be cited by students from Tan, where the capstone often extends over a single ten week term, the smallest time frame for the four schools.

Need for Cognition Lite (effect size = +.11)

The student surveys used five of the 18 items from the Need for Cognition scale in an abbreviated version to measure enjoyment of effortful cognitive activities. Studies indicate the full need for cognition scale is a relatively stable dispositional construct. The observed increase in this scale over a brief time period, though a small effect, along with the increase in an enjoyment in conducting research noted above, is evidence that capstones contribute to a precursor condition for lifelong learning. The increase occurred across all GPA levels at all schools. The GLM showed school*division as significant, which suggests that differences in the approaches of the divisions at different schools have an impact.

Estimated Marginal Means of Chg: An abbreviated version of the Need for Cognition scale designed to measure interest in or enjoyment of higher order cognition.



Covariates appearing in the model are evaluated at the following values: College GPA - Start of capstone year = 3.3166

Rating of Leadership/Collaboration Skills (effect size = +.17)

This scale incorporates public speaking ability, leadership ability, and social self-confidence. Although the overall result was an increase in each component item, the most uniform increase

across student types was for public speaking ability. A key component of most of the capstones in the study is a public presentation. The GLM showed GPA as significant.

There were only 37 (2%) student comments on development of collaboration skills. This is somewhat surprising given the importance students give to their relationship with their mentor. Evidently students don't see the work done with the mentor as being a form of collaboration.

Rating of Independent Voice (effect size = +.07)

The increase in this scale, which comes primarily from an increase in self-understanding, is reinforced by many student comments relating to developing an understanding of interests and abilities. Indeed, the small effect size is surprising given the emphasis this received in student comments. The GLM showed no significant differences by subgroups, although GPA was significant with a somewhat less stringent standard of $p \leq .1$.

Gaining self-understanding and an increase in self-confidence appeared in 162 student comments (9%). These two related categories speak to the relationship between gaining a better understanding of one's abilities and the consequent gain in confidence to tackle significant and challenging projects.

Students from the only school requiring a reflective statement as part of its capstone were only somewhat more likely, 4.9%, to cite self-understanding as a valuable outcome than the average of the other three schools, 3.4%.

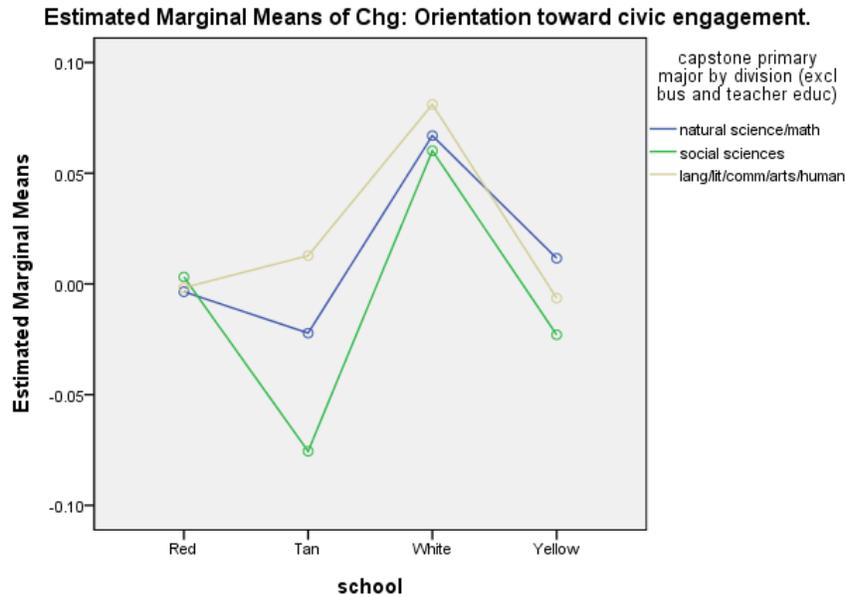
Rating of Striver (effect size = +.07)

The increase in this scale evidences an increased self-rating of a drive to achieve and of persistence, and is presumably related to experiencing the challenge of a sustained and difficult project, and related to such student comments as "I did it!". The GLM showed no significant differences by subgroups.

Student Scales with No Change

Civic Orientation

An increase in an orientation toward civic concerns (volunteer, helping others, community leadership, influencing social values, etc.) is a generally espoused goal of a liberal education, but was seldom mentioned in the focus groups or comments as an explicit goal of the capstone experience. One school incorporates a reflective component that asks the student to consider the value of the experience for society, but no significant change was observed for that school or any other school. Given the disciplinary focus of the capstone on the four campuses, the absence of an increase in this scale is not unexpected. As the lone exception among our student subgroups, civic orientation went up for the high GPA group.



Covariates appearing in the model are evaluated at the following values: College GPA - Start of capstone year = 3.3166

Status Career Orientation

Although this scale did not change significantly overall, the sub-item of “becoming accomplished in my field of expertise” as a life goal declined overall for most student categories and would appear to be the main contributor to the scale decline. To the extent that this scale reflects a desire for making more money and prestige, this is not an unfavorable result, but a decline in a goal of becoming accomplished in one’s field is, on the surface, an unexpected negative result worth exploring. Perhaps related to this is an unexpected small decline from 23% to 22% in the pre to post percentage of students, using matched data, that intend to pursue a doctorate. This was not a statistically significant decline, but an increase was anticipated and did occur for master’s degrees (+1%) and law degrees (+2%). It is possible that students who had applied to graduate, medical, or law programs at the time of the pre-capstone survey may have received a negative response by the time of the post-survey, leading to the decrease.

The following table shows the shifts among degree categories for seniors where both the pre and post responses were available. It shows considerable movement between categories: moving to a doctorate were 7% of those formerly intending to stay at the bachelor’s level, and 8% of those intending a masters. Moving the other direction, 4% of those intending a doctorate moved to the bachelor’s category and 12% to the master’s level.

Pre vs. Post: Advanced Degrees		Post: What is the highest academic degree you intend to earn in your lifetime?				Total
		1 Bachelor's	2 Master's	3 Law (JD)	4 Doctorate	
Pre: What is the highest academic degree you intend to earn in your lifetime?	1 Bachelor's	67	35	2	8	112
	2 Master's	48	476	3	46	573
	3 Law (JD)	1	8	49	3	61
	4 Doctorate	16	47	5	329	397
	Total	132	566	59	386	1143

The table is evidence that the capstone experience confirms doctoral degree interest for some while reversing it for others, with little overall net change. In that case, the capstone may serve a useful function in identifying through more informed self-appraisal the students who have the interest and abilities for doctoral studies. (Medical schools encourage some research experience or doctor shadowing for the same purpose.) The GLM showed a significant GPA effect and suggests higher increases for higher GPA students.

In survey comments, approximately 12% of seniors explicitly mentioned that their work on their capstone contributed to their professional development in some way. Preparation for graduate school (77 comments) or a job (48 comments) was cited by some. Another 28 comments specifically mentioned the creation of a product for a professional portfolio useful in a job search; 8 cited professional contacts as a benefit; 8 cited the development of interview skills; and 4 noted their capstone work would be published or was publishable.

By student subgroup, the highest GPA group students were more likely to cite this benefit (13%) than the lowest (9%).

Satisfaction with instruction

Satisfaction with instruction was high before and after the capstone, and not seeing a significant increase simply corresponds with continued high ratings. The GLM model showed no significant effects.

Student Scales That Declined

Higher order cognition (effect size = $-.07$)

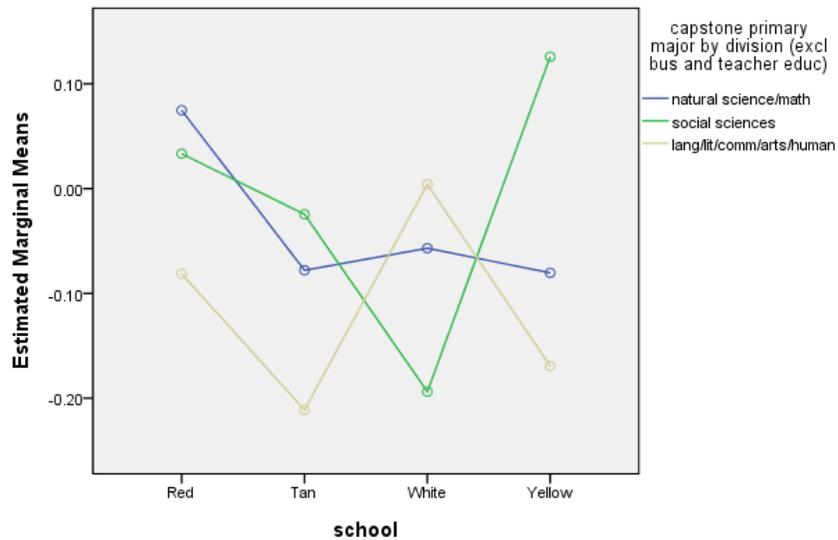
This scale is appropriated from NSSE (by permission) and also emerged during our factor analysis. While the decline is quite modest, it might have been expected that the use of higher order cognition would go *up* significantly during the capstone. Adding to this incongruity, it is somewhat puzzling that the higher order cognition scale would decline while the related need for cognition scale would increase. Although they are different, one measuring use of cognitive techniques, and the other enjoyment, the two scales might reasonably be expected to move together.

The higher order cognition scale is a comparison of practice of cognition skills prior to and during the capstone, while the need for cognition scale is a measure of enjoyment of cognition

effort during the capstone. Looking at the subcomponents, the decline came from “analyzing...ideas” and, most significantly, a decline in “applying theories or concepts to practical problems or in new situations” (effect size = $-.20$), while “synthesizing and organizing ideas, information, or experiences...” went up overall. Certainly the increase for “synthesizing...” seems valid and is supported by faculty reports, where an item on “synthesizes information” had one of the largest positive effect sizes.

We have no clear explanation for the decline in “applying theories or concepts to practical problems...” Speculatively, this result would seem to have some face validity for capstones if students don’t see their capstone as solving a “practical problem” or the skills developed as applicable to practical problems. While many capstones and, in general, research, require attention to both the practical and theoretical aspects of a discipline, capstone projects might be seen by students as predominantly theoretical. If this is the case, the decline in this scale is a misleading result from a nuance in the NSSE wording that doesn’t apply well to capstones. Another possibility is that the work of the capstone might be perceived as related to a liberal arts discipline and therefore not “practical” in a way that pre-professional training might be. Any follow-up projects might consider looking more closely at this. As with other aspects of the capstone, it may take time for the student to see some of the more general benefits of the capstone. The GLM model showed a significant school*division effect, so effects may have resulted from different approaches taken by the divisions at different schools.

Estimated Marginal Means of Chg: Use of higher order cognitive thinking skills (analyzing, synthesizing, judgments, applying theories).



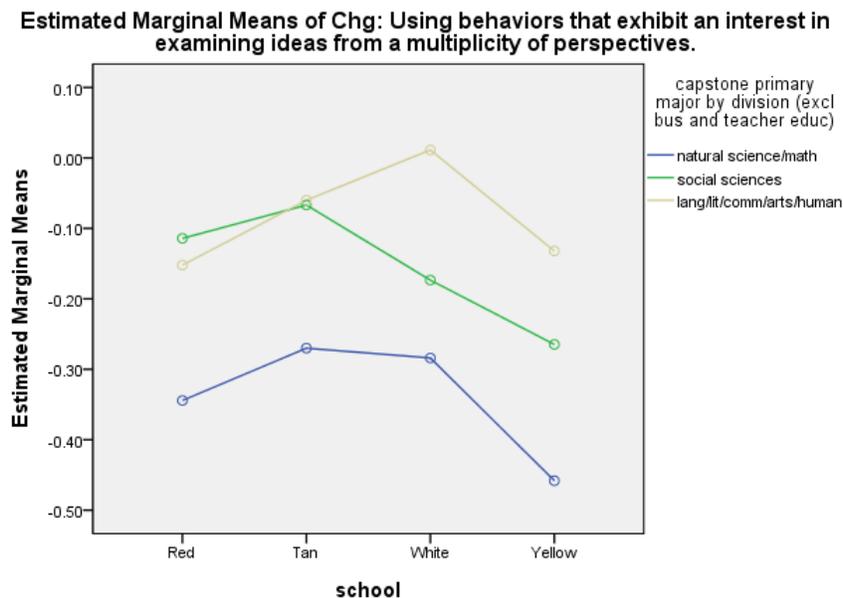
Covariates appearing in the model are evaluated at the following values: College GPA - Start of capstone year = 3.3242

Multiple Perspectives (effect size = $-.30$)

The decline in multiple perspectives contrasts with some popular perceptions of the capstone as a culminating experience integrating the four-years of college. In practice, it is more an in-depth experience in the discipline that integrates general education skills such as writing and critical thinking, but not necessarily ideas or concepts from other areas, and does not, as a

general rule, give emphasis to diverse perspectives based on race, religion, gender, or political beliefs. A decline in “tried to better understand someone else’s views....” also contributes to the decline in this scale and gives some pause, as this would seem to be a goal of the literature review of any inquiry, and critical thinking in general.

However, it may be that the question was interpreted to mean taking someone else’s *personal* views into account, as opposed to consideration of different scholarly positions on a subject. A decline occurs across all student subgroups (by school, major, GPA, and gender), but is greatest for Natural Science majors and low GPA students. A GLM model showed both the school and division with significant effects after controlling for GPA, with the estimated marginal means for the pre/post difference scores, broken down by school, shown in a plot below. The order of least decline, from Humanities to Social Sciences to Natural Sciences, is possibly related to how mathematical/technical each disciplinary area is; the more empirical disciplines perhaps placing less emphasis on consideration of various personal points of view on a topic. The GLM model showed significant effects by both school and division.



Covariates appearing in the model are evaluated at the following values: College GPA - Start of capstone year = 3.3378

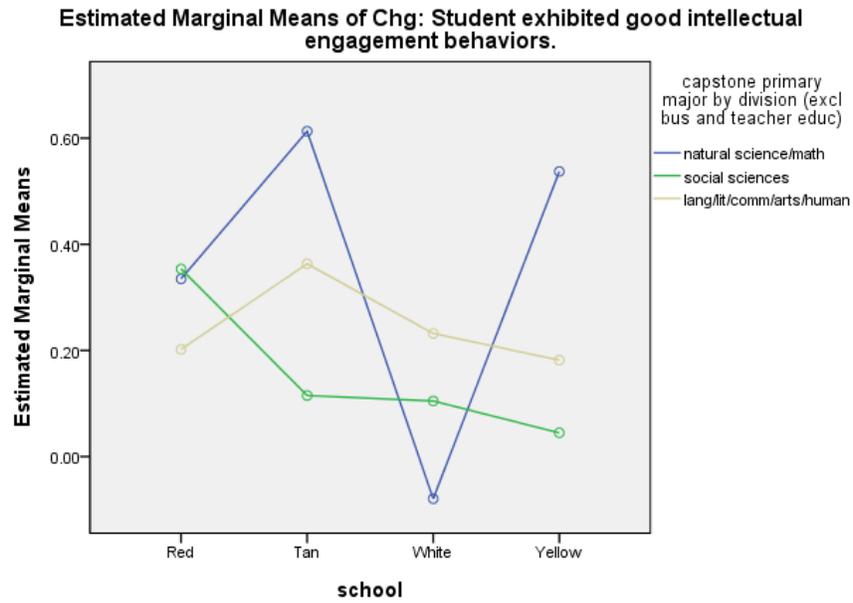
Satisfaction with support services (effect size = -.10)

This scale has subcomponents for rating of computer, library, and facilities/equipment services. The small decline is possibly a result of increased demand for these services resulting from capstones. Being highly individualized, capstone projects may require specialized equipment or computer software, reserved workspace (including laboratory or library space), special library resources, etc. The GLM model showed a significant GPA effect with higher GPA students showing more satisfaction. The absence of a significant effect by division or school indicates this is a general phenomenon and not concentrated, as might be assumed, in the disciplines with the largest laboratory needs.

ANALYSIS OF PRE/POST STUDENT CHANGE – MENTOR SURVEY RESULTS

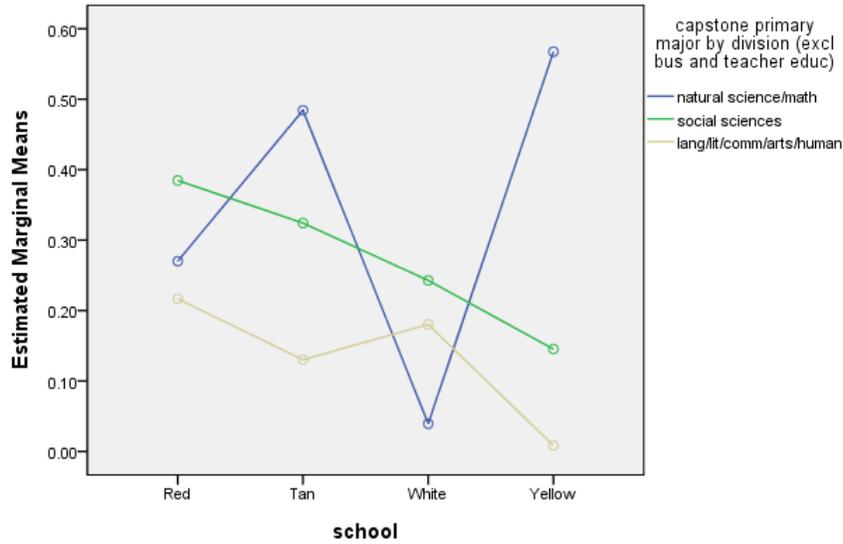
All four faculty mentor scales comparing faculty perceptions of student work during the capstone to their academic work in regular coursework prior to the capstone increased: communication skills (effect size = +.27), effective project management (effect size = +.35), intellectual engagement (effect size = +.34), and critical thinking skills (effect size = +.42) (see Appendix E). The evidence is that these scales went up for all four schools and student groups by major, GPA level, and gender.

In summary, faculty mentors seem very pleased with the performance of students during the capstone and feel it compares favorably with their performance during a regular course on these measures. A closer look at student subgroups using GLM univariate models showed that for the last three faculty scales listed above there were significant effects from the school*division interaction.



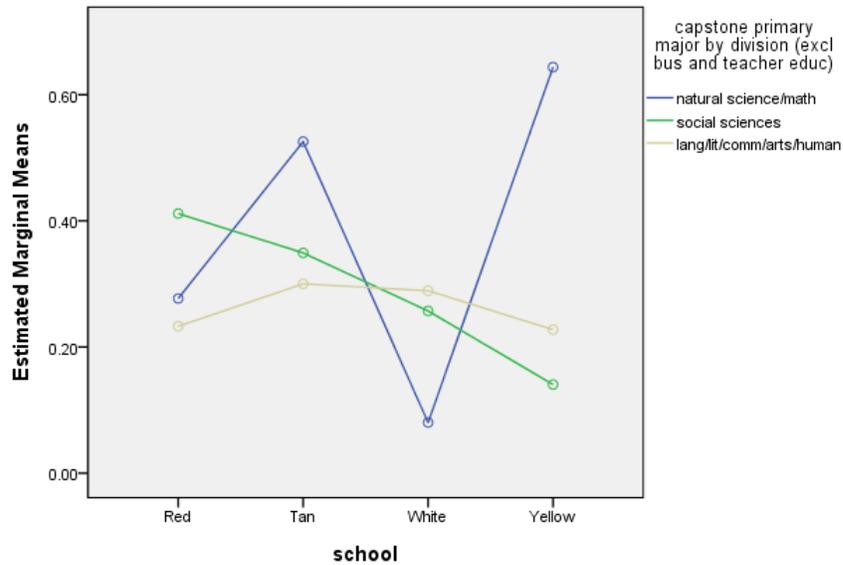
Covariates appearing in the model are evaluated at the following values: College GPA - Start of capstone year = 3.3270

Estimated Marginal Means of Chg: Student exhibited good project management skills.



Covariates appearing in the model are evaluated at the following values: College GPA - Start of capstone year = 3.3275

Estimated Marginal Means of Chg: Student exhibited good critical thinking skills.



Covariates appearing in the model are evaluated at the following values: College GPA - Start of capstone year = 3.3249

On the post-capstone report mentors completed for each of their advisees, mentors were asked to “Please note any particularly significant benefits you think the student gained from this capstone.” Because the question asked about “particularly significant” benefits, we expect that mentors concentrated only on the major benefits they observed. An unintended

consequence of this phrasing, however, is that it is difficult to interpret the absence of a response; does a blank response mean that the mentor saw no *significant* benefit, no benefit at all, or did the mentor just skip the question? If the pool of surveys is adjusted to remove those where the mentor left blank *all* open ended responses, a student benefit was cited for 572 (51%) of 1,126 capstones.

The comments describe a wide and varied range of benefits from specific academic skills to areas of personal and professional development, including an emphasis on building project management skills, self-confidence, and an interest in doing research. Moreover, the mosaic of benefits cited is directly related to distinctive characteristics of the capstone experience in that a student is expected to engage in an independent, large scale project of research or inquiry.

Project management benefits

Approximately 15% of the comments noted development of project management skills. For many students the capstone experience constitutes the largest academic project they have undertaken, making the capstone an important opportunity to develop planning, organizational, and time management skills. In combination with the results for a question about student preparation, for which mentors often noted that students came in poorly prepared to manage a large project, it would seem that capstones present an advising challenge – structuring the capstone in a way that balances the need for independence, while providing scaffolding such as deadlines, project goals, and feedback to ensure the student doesn't flounder. That most students develop in this area may be a particularly significant and distinguishing benefit of the capstone experience.

Academic skills development

The mentor's comments note enhancement of a number of the general benefits of a college education – development of writing or oral presentation skills (11%) and critical thinking skills (13%) in particular. But the capstone experience may develop these skills in an unusually powerful way. Comments suggest that a capstone experience develops these particularly well because the typical capstone project's scale is much greater than the usual work of a course, and because students explore a topic at a depth and with an independence not seen in most courses. Often capstone papers go through multiple revisions with mentor feedback and the results are prepared for celebrations of learning, conferences, or publication. Critical thinking skills are developed as students move through searching and analyzing related literature, designing a research protocol, analyzing data, and synthesizing and arguing a major thesis.

Self-development benefits

A variety of benefits cited are related to self-discovery, personal development, or "self-authorship." 13% noted a gain in the student's self-confidence; 9% noted a gain in self-understanding of abilities and interests; 4% reported a gain in an interest in doing research or writing or critical thinking; 3% reported development of a more mature approach to project behaviors – patience, perseverance, and taking responsibility. Many students begin the capstone apprehensive about their ability to successfully complete a significant long term project and end confident that they can achieve more than they thought.

Research skills and motivation development

10% of comments concerned development of specific research related skills – conducting literature searches, designing and conducting research, quantitative or qualitative analysis of data, laboratory skills, etc. 3% of comments reported an increase in technical skills related to research, and 4% reported an increase in the student’s motivation toward research or pursuing the capstone project.

Professional development benefits

7% of the comments about benefits concerned an area of professional development for graduate school or employment. These ranged from a simple statement that the student developed professionally or was better prepared for graduate or professional school, to statements that the capstone led directly to a job offer. Students were able to include their capstone work in an application portfolio, make professional contacts through conference attendance, gain recognition through presentations or publications, get better references from their mentors, or, in one case, start their own business.

Disciplinary knowledge

While gaining additional disciplinary content knowledge is certainly a benefit of most capstones, this was mentioned explicitly in only 38 comments (3%), as faculty concentrated on the more general benefits noted above.

STUDENT “COSTS”

As described above, the great majority of students indicated that their capstone experience was positive. However, the data identified three kinds of “costs”: stress, opportunity cost, and unachieved objectives. These three were the dominant themes in negative student comments, as evidenced by the percentage of the 1,150 capstones with any comment on that topic. The percentages given here are of capstones for which the student provided a comment, *not* the total number of capstones. It is not clear to what degree commented capstones are representative of *all* capstones, thus these percentages may be conservative.

Stress

Approximately 11% of senior post-capstone surveys that included answers to the open-ended questions mentioned that the experience was stressful. 84% of seniors agreed or strongly agreed that the capstone was more stressful than a regular course.

There are multiple sources of stress, some due to the nature of the capstone model and some unique to the student’s particular context.

High Stakes

That the capstone is done independently by each student, requiring greater responsibility for success or failure, and is also a high stakes requirement for graduation makes it a source of greater stress than a typical course. An ethos on some campuses that likens the capstone to master’s level work may aggravate this issue.

Challenge

Students find the work of the capstone experience to be generally more engaging than that of formal coursework, but also more challenging. Alumni agree that the capstone was more intellectually challenging than a regular course (68%), and that they developed more academically through their capstone than through a regular course (56%).

Among seniors surveyed there is an interesting distinction; higher GPA students are more likely to agree that their capstone will be intellectually challenging, while lower GPA students are more likely to think their capstone will be very stressful. The psychology of this distinction may involve motivational issues relating to success orientation versus failure-avoidance. We speculated that higher ability students are more likely to respond to the intellectual challenge as an opportunity to prove their abilities, while others are more concerned with simply being able to meet the challenge, which they believe will be stressful. The actual amount of stress reported by seniors post-capstone did not show a statistically significant difference by GPA. As noted above, the stress level was generally reported as high compared to a regular course.

Workload

Some stress may be a natural effect of needing to work harder on the capstone project than on regular courses. In the post-capstone survey, the response to “I worked harder on my capstone than on a regular course” was 4.37 out of 5, indicating strong agreement with the statement.

As an overall average, pre-capstone students expected to spend 14.16 hours per week on their capstone, a number remarkably close to the 14.11 hours per week students actually reported on the post-capstone survey. If accurate, this is an indication of effort well beyond that of a regular course, considering that national senior data indicates students report working about 10-11 hours per week on *all* their courses, and the capstone is generally taken simultaneously with other courses. This data suggests that part of the success of a capstone experience is that the capstone can be engaging enough to simply increase students’ time-on-task. As noted by others, time-on-task is associated with successful academic outcomes. In our case, the correlation of student time on the capstone and the rating of the capstone’s contribution to development and the rating of a successful capstone were .201 and .214, respectively, showing a modest positive association with the ratings, but not a dominant one. (Other stronger correlates are discussed later.)

Project-specific Stressors

Specific stress-related issues that emerged in the comments include unclear capstone policies or guidelines, delays in obtaining resources (such as library materials), delays in getting feedback from the mentor, and interruptions due to student or family health problems. For about 11% of the capstones, the student reported some dissatisfaction with the mentor, much of it about availability, meetings, feedback, or lack of guidance.

While the high expectations, duration, and time requirements contribute to the benefits of capstones (NSSE and the Wabash National Study, for instance, document the benefits of “time-on-task”), they are not without costs for students, as indicated above. About 8% of student comments reported that the capstone was stressful, difficult or disappointing, and about 5% that it was difficult to balance the capstone with other courses or personal activities. To a

certain extent the challenge of the capstone is a desirable design feature that drives growth, so this is an acceptable result.

On balance, the evidence suggests that the stress is manageable for most students and overcoming the challenge is often a source of pride. There were 14 capstones, about 1%, where the student comments appeared to report extreme or debilitating stress, another 2% reported a level of stress high enough to significantly interfere with other courses or activities. On the other hand, in many cases when stress was mentioned by students as a negative aspect of their capstone experience, the students added a disclaimer that it was worth it and a natural part of the experience. In reading the remarks, one has the sense that the balance ought to be judged even more positively based on the relative weight of the statements. For instance, a frequent combination might cite strong personal or academic gains, but note the stress or amount of the work as a negative along with a disclaimer that it was worth it. This judgment is reinforced by the results from another question: when asked if “Overall, I had good capstone experience,” among these same 1,149 students, 963 agreed or strongly agreed (84%), while only 63 (5%) disagreed or strongly disagreed.

Opportunity Cost

The opportunity costs from working on capstones rather than spending time on other courses, co-curricular activities, or personal activities was noted by about 7% of seniors as another significant “cost.” Data from our alumni survey, however, does not generally indicate seniors are less involved in co-curricular activities, but does point to study abroad as a notable area where there may be a trade-off with capstones. Comparative data from the alumni survey relating to the level of activity in various areas as an undergraduate (not necessarily as seniors) suggests that in comparison to peer institutions, our graduates are significantly more involved in independent study and faculty research, significantly less involved in study abroad, modestly less involved in intramural sports and religious groups, but about as involved in many other activities, including student government, intercollegiate athletics, performing arts/music, political organizations, community service, social fraternities and sororities, and internships. On balance, our data (particularly alumni data) suggest that the benefits outweigh the opportunity costs for most students, but the opportunity costs may be significant for students with interests in other valuable opportunities, notably study abroad.

Failure to Achieve Goals

In a few cases, despite the effort expended, the student fell short of achieving one or more goals – improving a skill, career preparation, self-understanding, etc. This is somewhat an imposed construct in that student comments only noted not achieving a goal as a negative feature of the capstone. For purposes of this cost/benefit analysis this is being interpreted as a “cost” because of the effort expended with the student asserting a lack of benefit.

BENEFITS AND COSTS FOR FACULTY MENTORS

While the greater part of the study looked at the impact of the capstone experience on the student, we also wanted to understand better how mentors perceived the capstone and the capstone's impact on the mentor.

The post-capstone survey the mentor completed for each of his/her students included an open-ended question asking about positive or negative aspects of that particular capstone experience for the mentor. In addition, ninety-minute focus groups were held on each campus with a group of tenured and, separately, a group of untenured faculty members.

Although the capstone project formats vary from campus to campus, faculty members described a common set of purposes for the senior capstone:

1. *The capstone experience is a four year process that culminates in a senior project.* The capstone program "is an academic journey, a four year process" that "provides a framework for thinking and inquiry, and brings cohesion to the curriculum." In the first three years both the general education and department curriculum intentionally prepares students for the senior year project, requiring "backward design" of the curriculum.
2. *To require students to "take ownership of the learning process" and practice active learning.* The capstone is a uniquely independent and self-directed learning experience.
3. *To move students from studying in a discipline to practicing a discipline.* To move students from studying philosophy to being a philosopher, from being students to being practitioners.
4. *To require students to complete a substantial sustained research project requiring organizational and time management skills.*
5. *To require students to demonstrate advanced research and analytical skills, and to integrate and synthesize previously learned material.*

Faculty members at the four institutions had a similar description of a "successful" capstone project as one in which the student: a) is self-directed and takes full responsibility for his/her learning; b) communicates his/her interest and passion; c) demonstrates advanced analysis, research, and writing; d) provides evidence of growth and change; and e) develops an innovative, novel, or original research question.

Faculty participants at the four schools voiced nearly unanimous commitment to the universal requirement, and shared the belief that *all* students benefit significantly (though not equally) from the capstone experience. Many mentors cited examples of average or weak students who "caught fire" or "blossomed" and produced an outstanding paper. One mentor shared a department study that concluded "there's no correlation between how our majors do in our courses and how well they do on their projects."

Faculty participants were universally positive about their experiences as capstone advisors. They described a common advising role that included: a) guiding the shaping of a feasible, well-defined topic and research question; b) meeting regularly and providing needed structure, direction, and deadlines; c) providing encouragement and emotional support (coach, advocate, cheerleader); d) reviewing, challenging, and critiquing an advisee's thinking and writing; and, e)

consulting as a “co-learner” and academic colleague. Many faculty advisors performed the additional roles of mentor, friend, life coach, and career counselor. There was considerable conversation in the focus groups about striking the right balance between providing a degree of guidance and direction while taking care to honor the advisee’s independence and autonomy.

Faculty mentors take their capstone advising responsibilities very seriously, many devoting significant time and energy to each student. Consequently, most mentors are challenged to find adequate time for capstone advising, and those with large advising loads (more than 5 advisees) often find it affecting their teaching or their own research and writing. Although most faculty members appreciate the workload compensation arrangement in the form of course release, many feel the allotment ratios are inadequate.

In post-capstone survey comments, mentors viewed their own experience primarily through the lens of their relationship with the student and the development and success of the student and the project. Indeed, only 33% of the responses to the question asking about positive or negative aspects *for the mentor* were explicitly about the mentor’s own experience of the capstone, with 54% focused on the student and 6% on the capstone product. Of the comments on their *own* experience, 69% were positive and 31% were negative.

Positive aspects of the mentor’s experience:

- Enjoyment of working one-on-one with students: exchanging ideas, seeing projects and students develop, working with a student that was particularly capable or motivated as a colleague.
- Learning about the topic of the student’s project, in some cases because it contributed to their own research interest, but more frequently because it was simply of interest or intellectually stimulating. Some found it valuable when the topic was outside their area of expertise, but others noted the extra work required in these cases. However, a very small number of comments complained about repeatedly supervising capstones on the same topic (e.g., Hitler or the Civil War).
- Making new professional contacts as a result of working with a project outside their normal scholarly niche.
- Working on a project that had a successful outcome in meeting or exceeding expectations in terms of design, ideas, originality, results, or general quality.
- Improving their teaching, mentoring, or advising skills as a result of the closer relationship with the student that enabled personalizing their approach and observing and analyzing the results.

A selection of mentor comments captures these benefits:

- *I observed that [the student] blossomed in terms of her writing skills and even her intellectually approach during the course of her capstone research. She was a pleasure to work with - not an extremely strong student, but one who really responded to suggestions and advice.*
- *[This student] is a superstar with respect to [the capstone]. She was able to work independently, take complete ownership of her project, effectively manage her time, and analyze her results. This mentoring relationship really felt more like a colleague/colleague relationship which was wonderful.*

- *This student experienced more growth through this process than any other student I have mentored. It is gratifying to see a weaker student begin to synthesize the knowledge from various courses, and to achieve success through hard work.*
- *I really enjoyed this project. The student was incredibly engaged and we had a lot of fun discussing her ideas. I watched her writing go from being very weak to quite strong. She took ownership of the project and did a great job.*
- *Wonderful to see the student grew in confidence and understanding of methods and limitations of research.*
- *The chosen topic was an application of mathematics to an area where I had no experience. I learned as much as the student and learned it almost completely through her explanations.*
- *It made me think of an interesting problem that I plan to study in greater depth.*
- *All the way through the process it was a delight to work with this student, who was so disciplined, organized, self-motivated, and responsive to my suggestions and comments.*
- *[This student] achieved some intellectual thinking/work in this project that I didn't think possible. I saw her flourish intellectually and take ownership of the project.*

Negative aspects of the mentor's experience:

- Frustration from the additional work and the emotional toll that accompanies mentoring students who are poorly prepared, unmotivated, and/or unresponsive to feedback (almost 12% of capstones).
- Students who delayed starting on their project or didn't meet project deadlines, missed meetings with the mentor, and generally couldn't work independently and needed to be micromanaged.
- Stress from feeling responsible for the student's performance and the quality of the product. This stress is particularly acute due to the high stakes of not passing a student.
- Several negative remarks related to difficulties stemming from co-advising, for example a project for a double major, or the student being off-campus and working with an adviser from another institution. All but one of the 25 comments explicitly relating to co-advising a project was negative.
- The workload of advising capstones as well as the time and effort needed to develop the mentoring skills required of capstones. A relatively small number of responses, 17, related explicitly to the workload as an onerous addition to other duties. Another 22 comments noted the extra work of advising a capstone that was outside their area of expertise, which has workload implications. Additional concerns included workload that is not reflected adequately in institutional load formulas. Numerical results from a GLM suggest that the degree to which the capstone topic aligned with the mentor's area of expertise varied by school and academic division. For two schools the alignment appeared greater for the Natural Sciences.
- Time from research, other duties. An underlying issue is faculty identity, what faculty members believe is part of their duties, what is valued by the institution and outside the institution, and what will contribute to a successful career.
- There were a small number of reports of support issues with equipment, software, administrative support, etc.

A selection of mentor comments captures these costs:

- *This student had a poor work ethic and had to be constantly prodded (to the point of threatening a failing grade) to pursue the project. The result was mediocre work, barely meeting the standard for the lowest passing mark. Advising a student who takes little initiative is an exhausting process!*
- *This student was simply not prepared to design, conduct and write a senior thesis. It was as if she had not been exposed to the theory and methods of anthropology. She showed little interest in conducting research, and consistently prioritized other events over this project.*
- *This was a struggle... this student showed exceptional academic and intellectual skills in coursework, but that did not turn out to be an adequate predictor of just how much mentoring [was] needed. I underestimated how much direction she needed. When faced with a project all her own she became hamstrung. I intend to modify my [capstone] expectations and advising/mentoring process in the future to avoid reoccurrence of this scenario.*
- *Capable student but often refused to put in the time and effort to actually get things done. Makes this frustrating.*
- *An integrated capstone for a double major. Not very successful. Both advisors were frustrated. This experience has made me a bit more skeptical of letting mediocre students do integrated capstones.*
- *This was a frustrating experience. The student displayed very poor time management and did very little with the feedback that was provided.*
- *When I have multiple students that are working on multiple independent yet unrelated projects, it becomes difficult to manage all of the teaching of experimental techniques that is required. I could try to steer all of my students to only the project that I want/need them to work on, but I feel like this defeats the process of independent study.*
- *This student is an example of why all students should not be required to complete the [capstone]. This was excruciating. Her approach to data collection was sloppy, analysis was uninformed, she seemed incapable of identifying her weaknesses....*

The capstone enables many students to shine, and mentors find this an enjoyable and highly rewarding experience. Other students struggle, due to lack of motivation, preparation, or abilities, and mentors find this frustrating.

The conclusion from the comments of mentors in our surveys and focus groups is that the great majority of faculty members support the capstone program because they see it as a positive experience for students. When given the opportunity, mentors were more inclined to comment on student success (or problems) than they were on how the capstone affected them personally. Major factors in how mentors view their experience with the capstone include how well the student performed relative to their expectations and how well the mentor and student collaborated. While mentors enjoy working with the majority of their advisees, mentors are frustrated with the quality of work or the effort/motivation in almost 12% of capstones. The length, scale, and high expectations for capstone projects, as well as the need for students to work independently, tend to expose and amplify issues with student preparation, skills, and work ethic.

USING THE SCALES TO INVESTIGATE KEY QUESTIONS

Below we look at what the data show concerning several questions relevant to our study. In the tables and text there are references to survey questions that were repeated in the pre- and post-capstone surveys, along with associated scales. For those questions a difference score could be computed to quantify pre- to post-capstone change, if any. Pre-capstone, post-capstone, and difference score values are denoted by prefixes of “Pre”, “Post” and “D,” respectively; for example, PreResearchOrient, PostResearchOrient, and DResearchOrient.

Do mentor reports of student success agree with student self-assessments?

The following questions are of interest for purposes of cross-validating student and faculty assessments, and for the design of reliable assessment instruments. The analysis here is based on data from 2009/10.

- Do the four mentor evaluation scales align well with the seven mentor summative evaluation items?
- Are faculty mentor reports of student performance consistent with student self-assessments?
- Do mentor evaluations align with students assessments of their preparation for the capstone?

Mentor Evaluation Fields

The analysis of the post-capstone mentor surveys is aided by reducing the data to four scales and seven summative items that summarize the mentor’s rating of the student’s performance. The four scales are each computed as the average values of several detailed items on which the mentor rated the student’s ability, practice, and performance as demonstrated during the capstone. The items were grouped together as a scale based on factor analysis. In contrast, the seven summative items are the mentor’s rating of the extent the capstone contributed to the student’s development in each of the seven areas.

Four performance rating scales:

PostCommunSkills	Student exhibited good communication skills
PostEffProjectMgt	Student exhibited good project management skills
PostIntelEngagement	Student exhibited good intellectual engagement behaviors
PostCrThinkSkills	Student exhibited good critical thinking skills

Seven summative items in the evaluation of capstone’s contribution to development:

PostFac27	<i>Independence</i> : Showing autonomy and initiative in thought and actions
PostFac28	<i>Intellectual Engagement</i> : Demonstrating an interest in learning
PostFac29	<i>Self-understanding</i> : Developing an awareness of self (skills, abilities, interests)
PostFac30	<i>Project Management</i> : Conceiving and managing a project
PostFac31	<i>Research</i> : Investigating in a manner appropriate to the discipline
PostFac32	<i>Critical Thinking and Reasoning</i> : Evaluating and constructing arguments with evidence
PostFac33	<i>Communication</i> : Presenting ideas effectively (written, oral, and other forms)

Consistency of Mentor Evaluations

Table 1 shows the correlations among these 11 items. All the correlations are statistically significant at $p \leq 0.05$, two-tailed. The four scales are all highly correlated with each other, with a correlation of .700 or higher. The summative items are also highly correlated with each other and with the four scales. The correlation of each of the four scales with the summative item most closely aligned with it (by topic) is particularly high. For instance, the summative item about critical thinking has a correlation of .783 with the critical thinking scale. Given these correlations, the interpretation of the four scales is reinforced, and it might be argued that using just the summative items in further analysis will reveal most of the findings of interest using a shorter survey instrument.

Consistency of Student Reports and Mentor Evaluations

Table 2 shows the correlations of the mentor evaluations with the student scales from the post-capstone student surveys. Correlations that are statistically significant at $p \leq .05$ are bolded and shaded. All the significant correlations are positive, indicating generally good correspondence between the mentor and student ratings for capstone performance. Other notes:

- The two key indicators of students' rating of the capstone, PostCapSuccessful and PostCapContDev, correlated positively with all 11 of the mentor ratings.
- All 11 mentor ratings also correlated positively and significantly with PostMentorRel, PostSatisInstr, PostExhibScholarlySkills, PostProjMgt, PostResearchOrient, and PostRatingStriver. Thus, on the mentor's side, high evaluations of the student's performance are generally associated with, as reported by students, a good student/mentor relationship, higher student satisfaction with instruction, and students' feeling that they were good project managers, persisted through difficulties, exhibited good academic skills, and enjoyed doing research.

Capstone preparation and faculty assessments of performance

Mentor evaluations had surprisingly weak correlations with students' assessments of the helpfulness of various forms of preparation for the capstone.

- PostPrepDisc had a statistically significant correlation with only one of the four scales (.140 with effective project management), while PostEffProjectMgt, PostPrepBreadth, and PostPrepQuant did not have a statistically significant correlation with any of the four scales.
- Looking at the seven summative evaluations, disciplinary preparation has a statistically significant, but small correlation with 5 of the 7 items, while the "breadth" preparation associated with general education programs has a statistically significant correlation only with self-understanding (.105). Quantitative preparation did not have a statistically significant correlation with any of the seven items. However, these low correlations are difficult to interpret. For example, the low correlation between quantitative preparation and the mentor ratings may reflect the fact that for Humanities and some Social Science students, quantitative preparation is irrelevant, so receives a very low rating. Yet these students do well on their capstones and receive high ratings from mentors. This may be the case with some of the other low correlations.

Student Evaluation Scales

The student scales of interest are:

PostPrepBreadth	Helpfulness as preparation for the capstone of areas that add educational breadth.
PostPrepDisc	Helpfulness as preparation for the capstone of areas that are grounded in the disciplinary major of the capstone.
PostPrepQuant	Helpfulness as preparation for the capstone of quantitative or computer based techniques.
PostMentorRel	Helpful and comfortable relationship with the mentor.
PostCapContDev	Rating of the contribution of the capstone to the development of scholarly skills.
PostCapMoreEngaging	Rating of the capstone as more or less intellectually engaging than a regular course.
PostCapSuccessful	Overall assessment of the capstone as a successful experience.
PostSatisInstr	Satisfaction with instruction.
PostSatisSuppSrv	Satisfaction with academic support services (library, computer, facilities/equipment supporting their major).
PostCivicOrient	Orientation toward civic engagement.
PostHighOrderCogn	Use of higher order cognitive thinking skills (analyzing, synthesizing, judgments, applying theories).
PostExhibScholarlySkills	During the past academic year (pre) or during the capstone (post) the student exhibited scholarly skills, including critical thinking, disciplinary knowledge and methods, communication skills, independence and persistence.
PostNeedCognLite	An abbreviated version of the Need for Cognition scale designed to measure interest in or enjoyment of higher order cognition.
PostMultPerspectives	Using behaviors that exhibit an interest in examining ideas from a multiplicity of perspectives.
PostProjMgt	Exhibiting good project management skills.
PostRatingAcadAbil	Student's self-rating of his/her academic ability.
PostRatingLeadCollabSkills	Student's self rating of his/her group leadership/collaboration skills, including public speaking, leadership and social self-confidence.
PostRatingIndepVoice	Student's self rating of his/her academic ability, including critical thinking, writing, creativity, and general academic ability and self-confidence.
PostResearchOrient	Student's self-rating of his/her drive to achieve and persistence
PostRatingStriver	Enjoyment of research.
PostStatusCareerOrient	Desire to have a prestigious, high paying, and high achieving career.

Overall it appears that the students' sense of their preparation doesn't relate strongly with the mentors' evaluations of performance. This was particularly true for quantitative preparation. These results might be seen as consistent with the data for the MultiplePerspectives scale that suggests that the capstone experience is, on average, more an in-depth experience in the major than an experience that integrates the four-year college experience.

It seems reasonable to conclude that the mentors' ratings are generally consistent with students' own perceptions of their performance. Moreover, the correlation of mentors' ratings with students' feeling more positive about the mentor relationship underscores the importance of the student/mentor relationship as a possible contributor to better capstone performance. Mentor evaluations had only weak correlations with student assessments of the helpfulness of various forms of capstone preparation. Further investigation of cases where the student and mentor reports are out of sync might be of interest.

Table 1: Correlations of Faculty Evaluation Fields	Scales				Summative Items							
	PostCommunSkills Student exhibited good communication skills.	PostEffProjectMgt Student exhibited good project management skills.	PostIntelEngagement Student exhibited good intellectual engagement behaviors.	PostCrThinkSkills Student exhibited good critical thinking skills.	PostFac27 Independence: Showing autonomy and initiative in thought and actions	PostFac28 Intellectual Engagement: Demonstrating an interest in learning	PostFac29 Self-understanding: Developing an awareness of self (skills, abilities, interests)	PostFac30 Project Management: Conceiving and managing a project	PostFac31 Research: Investigating in a manner appropriate to the discipline	PostFac32 Critical Thinking and Reasoning: Evaluating and constructing arguments with evidence	PostFac33 Communication: Presenting ideas effectively (written, oral, and other forms)	
PostCommunSkills Student exhibited good communication skills.	1	.737	.713	.781	.563	.528	.598	.631	.637	.650	.702	
PostEffProjectMgt Student exhibited good project management skills.	.737	1	.837	.857	.708	.708	.743	.794	.773	.757	.720	
PostIntelEngagement Student exhibited good intellectual engagement behaviors.	.713	.837	1	.873	.757	.748	.717	.700	.755	.774	.687	
PostCrThinkSkills Student exhibited good critical thinking skills.	.781	.857	.873	1	.687	.659	.712	.705	.765	.783	.705	
PostFac27 Independence: Showing autonomy and initiative in thought	.563	.708	.757	.687	1	.761	.719	.679	.720	.759	.700	
PostFac28 Intellectual Engagement: Demonstrating an interest in learning	.528	.708	.748	.659	.761	1	.727	.683	.745	.749	.705	
PostFac29 Self-understanding: Developing an awareness of self	.598	.743	.717	.712	.719	.727	1	.716	.750	.752	.746	
PostFac30 Project Management: Conceiving and managing a project	.631	.794	.700	.705	.679	.683	.716	1	.791	.738	.730	
PostFac31 Research: Investigating in a manner appropriate to the	.637	.773	.755	.765	.720	.745	.750	.791	1	.820	.743	
PostFac32 Critical Thinking and Reasoning: Evaluating and	.650	.757	.774	.783	.759	.749	.752	.738	.820	1	.795	
PostFac33 Communication: Presenting ideas effectively	.702	.720	.687	.705	.700	.705	.746	.730	.743	.795	1	

Faculty Scales

Table 2: Correlations of Faculty Rating Scales with Student Scales	PostCommunSkills	PostEffProjectMgt	PostIntelEngagement	PostCrThinkSkills
PostPrepBreadth	.036	.058	.092	.037
PostPrepDisc	.079	.140	.092	.082
PostPrepQuant	-.006	.066	-.039	.022
PostMentorRel	.111	.125	.189	.182
PostCapContDev	.146	.208	.205	.203
PostCapMoreEngaging	-.010	.110	.102	.097
PostCapSuccessful	.142	.232	.232	.247
PostSatisInstr	.179	.192	.185	.212
PostSatisSuppSrv	.042	.052	.015	.040
PostCivicOrient	.027	.116	.074	.058
PostHighOrderCogn	.143	.121	.162	.143
PostExhibScholarlySkills	.228	.269	.245	.271
PostNeedCognLite	.076	.076	.151	.115
PostMultPerspectives	.067	.127	.152	.095
PostProjMgt	.222	.321	.211	.276
PostRatingAcadAbil	.250	.171	.270	.245
PostRatingLeadCollabSkills	-.028	.074	.116	.053
PostRatingIndepVoice	.042	.020	.061	.004
PostResearchOrient	.229	.239	.263	.281
PostRatingStriver	.167	.225	.183	.205
PostStatusCareerOrient	.101	.097	.087	.123
DSatisInstr	.155	.125	.084	.147
DSatisSuppSrv	.031	.027	-.002	.018
DCivicOrient	.021	.014	-.029	-.032
DHighOrderCogn	.045	.005	.064	-.002
DExhibScholarlySkills	.062	.040	.049	.049
DNeedCognLite	-.003	.038	-.002	-.009
DMultPerspectives	.019	.050	.032	-.002
DProjMgt	.062	.122	.097	.155
DRatingAcadAbil	.002	-.010	.004	-.017
DRatingCollabSkills	.089	.120	.116	.075
DRatingIndepVoice	.142	.057	.074	.073
DRatingStriver	.023	-.026	.024	-.008
DResearchOrient	.012	-.059	-.056	.000
DStatusCareerOrient	.047	-.001	.050	.065

What maximizes the capstone's contribution to development?

A key question is which aspects of the capstone are significant contributors to student development. To look at this a wide variety of variables were used in a series of regression models aiming to model responses to the PostCapContDev scale (rating of the contribution of the capstone to the development of scholarly skills). The final model resulted in the following list of survey items that had statistically significant coefficients, $p < .05$. These are listed in order of descending importance based on the standardized Beta coefficients for the model.

Item	Beta
PreExpectGoodCapstone Student expects capstone experience to be helpful.	.263
PostStu57 Making judgments about the value of information, arguments, or methods, such as examining how others gathered and interpreted data and assessing the soundness of their conclusions.	.220
PostMentorRel Helpful and comfortable relationship with the mentor.	.211
PostPrepDisc Helpfulness as preparation for the capstone of areas that are grounded in the disciplinary major of the capstone.	.191
PreRatingStriver Self-rating of drive to achieve and persistence.	.113
PostStu214 When the project started, how enthusiastic were you about your capstone topic?	.082
PostPrepBreadth Helpfulness as preparation for the capstone of areas that add educational breadth.	.064
PreCivicOrient Orientation toward civic engagement	.064
PostStu53 On average, how many hours per week did you spend working on ALL aspects of your capstone combined?	.059

The model (and other data such as student comments) suggests development is related to:

Positive student expectations

Positive expectations are related to participating in the selection or development of the capstone topic, having positive feelings about the mentor, feeling they are well-prepared, and, to a notably less degree, their rating of their academic ability. Fortunately, students generally have high expectations for the capstone experience. They tend to strongly agree that their capstone will be intellectually challenging, that they will be comfortable working with their mentor, that they will improve their knowledge of their disciplinary and critical thinking skills, and that they will increase their understanding of their own abilities and interests. They are less likely to agree that the capstone will clarify career or graduate school goals, a result consistent with a hypothesis that most students feel they have made their key career or graduate school decisions prior to the start of the capstone.

Eliciting higher order cognition

Making judgments about the value of information, arguments, or methods, such as examining how others gathered and interpreted data and assessing the soundness of their conclusions emerged as the specific variable associated with development. Broadly, this points to the value of capstones that are selected or designed to elicit higher order cognitive skills.

A positive relationship with the mentor

Students agreed that the one-on-one student/faculty advising relationship was an important component in the capstone experience, and for most students the support, encouragement, guidance, and constructive critiquing from their advisor were critical for a successful project and a positive experience. Student comments indicate the relationships ranged from close friend/mentor to helpful advisor to distant critic to unavailable paper reader; fortunately most were helpful and supportive.

On a five point scale, the expanded list of items asking about the student/mentor relationship showed generally high marks for the mentor's rapport with the student, including being interested in the project (m=4.44), encouraging the student's independence (m=4.49), and being comfortable to work with (m=4.47). In what seems to be an inconsistency, the mean for "my mentor effectively guided me through the capstone," m=4.19, was lower than all the related specific guidance items, such as sufficient feedback (m=4.29) and useful feedback (m=4.39). Perhaps there is some important aspect of mentoring that was missed in our survey that contributes to this discrepancy. Nonetheless, the overall results indicate students perceive a high level of mentoring ability on the part of faculty.

Similarly, mentors rate their own performance highly. They thought they gave the student sufficient access (m=4.64) and useful advice (m=4.55), but were less confident that they provided helpful subject matter expertise (m=4.30) or effectively guided the student through the capstone (m=4.28).

Good capstone preparation in prior coursework

Most students across all four campuses and all three academic divisions felt well-prepared for their capstone project, citing: 1) previous coursework in the major; 2) the capstone junior seminar or methods course; and, 3) the research and writing intensive courses throughout the curriculum as particularly helpful.

Not surprisingly, students consider courses in the major or minor, including a junior or senior seminar, as the most important preparation, m=3.46 on a 4-point scale. Surprisingly, however, courses outside the major, which includes general education courses, are rated markedly lower, m=2.10, just above volunteer experiences, m=2.06, and much lower than general non-academic interests/experiences, m=2.74. This might be explained by students perceiving this question to be only about content preparation and ignoring general skill development. A related possibility is that most capstones are done within the major and are typically focused on a narrowly-defined topic, making the relevance of coursework within the major appear to be higher than for non-major coursework. If so, it is consistent with a finding that capstones generally do not integrate knowledge from curricular areas outside the major. Another possibility is that students have not had sufficient time to reflect on what went into their capstone and which parts of their undergraduate experience contributed, directly or indirectly, to their preparation.

Students in the Natural Sciences were the least likely to find courses outside the major/minor useful (1.95) and the most likely to find courses in the major/minor to be useful (3.52).

Good capstone preparation from prior research experiences

The four participating schools provide extensive pre-capstone research opportunities. 78% of respondents indicated they experienced a course-embedded research project prior to their capstone (with almost equal participation across the three academic divisions), 41% completed an independent study course/project, and 24% completed a summer research project. Students in the Natural Sciences were most likely to have had a summer research experience of greater than four weeks and to have been a research assistant during the academic year. Students in the Humanities were the least likely to have had these experiences.

Time on task

Students report spending an average of 2.86 hours per week interacting with their mentor in individual or group meetings, and working an average of 14.1 hours per week on *all* aspects of the capstone. Students in the Natural Sciences report meeting for an hour more per week than students in the Social Sciences and Humanities. Lower GPA students report meeting with the mentor for an hour more per week than students in the medium and higher GPA ranges, but spending approximately the same total amount of time per week as students in the other GPA ranges. This may suggest that they have greater difficulty working independently.

An implication from the above findings regarding factors that maximize the capstone's contribution to development is that importance should be placed on the manner in which topics and mentors are selected so that students are interested in and have enthusiasm for their topics, and are comfortable working with their mentors. Some student input in negotiating both would seem to be highly desirable. It should be noted that the survey timing was at the beginning of the capstone so the ExpectGoodCapstone rating was made after the topic and mentor were known for most students and would incorporate both of those aspects. The use of higher order cognition in terms of making judgments about information, arguments, and methods also implies that mentors need to design or tailor the capstone project to elicit those critical thinking skills. Finally, higher time-on-task is related partially to interest and enthusiasm, as evidenced by a correlation of 0.31 between PostStu53, hours per week, and PostCapMoreEngaging, with high expectations for student performance being another dimension.

What contributes to a student's rating of the capstone as successful?

Similar to the contribution to development analysis, a series of regression models resulted in the following list of significant variables relating to higher ratings by the student of the capstone as a successful experience, based on the standardized Beta coefficients for the model.

Item	Beta
PostCapMoreEngaging Rating of the capstone as more or less intellectually engaging than a regular course.	.294
PostStu215 When the project ended, how enthusiastic were you about your capstone topic?	.236
PreExpectGoodCapstone Student expects capstone experience to be helpful	.181
PostPrepBreadth Helpfulness as preparation for the capstone of areas that add educational breadth.	.122
PreProjMgt Exhibiting good project management skills	.113
PostStu213 How satisfied were you with the process used to select your capstone topic?	.111

Item (continued)	Beta
PostMentorRel Helpful and comfortable relationship with the mentor.	.101
PostStu58 Applying theories or concepts to practical problems or in new situations	.087
PostStudentTopicMotiv Mentor rating of students enthusiasm for the topic	.068
PostStu54 Memorizing facts, ideas, or methods so you can repeat them in pretty much the same form	.049
PostStatusCareerOrient Desire to have a prestigious, high paying, and high achieving career.	.049
PostStu57 Making judgments about the value of information, arguments, or methods, such as examining how others gathered and interpreted data and assessing the soundness of their conclusions	.048

As in the list for the contribution to development, broadly speaking, items in this list relate to pursuing a project of interest to the student and believing the student has the preparation and mentor support necessary to succeed. Engagement with the capstone topic, preparation, the mentor relationship, and critical thinking emerge as significant aspects, although with somewhat different variables. Satisfaction with the process used to select the capstone topic is likely related to interest or enthusiasm for the topic. Having utilized good project management skills in courses prior to the capstone is a new area in this list and points to the value of preparatory courses incorporating some projects that require aspects of organization, planning, and time management. Student comments about the capstone show project management as a significant area of development.

Is there evidence of an impact from the capstone’s expectation of independence of thought and action on the part of the student?

Encouraging student independence is a strongly positive aspect of capstones. Students’ perceptions of the mentor encouraging their independence are positively and significantly correlated with a large number of favorable scale outcomes, including pre/post changes in the development scales. The following table lists the correlations of $\geq .2$ in descending order. In particular, independence is highly associated with a positive mentor relationship and ratings of the capstone’s success and contribution to development.

Correlations With PostStu216 My mentor encouraged my independence	Corr.
PostMentorRel Helpful and comfortable relationship with the mentor.	.717
PostCapSuccessful Overall assessment of the capstone as a successful experience.	.376
PostCapContDev Rating of the contribution of the capstone to the development of scholarly skills.	.368
PostSatisInstr Satisfaction with instruction.	.344
PostExhibScholarlySkills During the past academic year (pre) or during the capstone (post) the student exhibited scholarly skills.	.339
PostHighOrderCogn Use of higher order cognitive thinking skills (analyzing, synthesizing, judgments, applying theories).	.256
PostProjMgt Exhibiting good project management skills.	.244
PostCapMoreEngaging Rating of the capstone as more or less intellectually engaging than a regular course.	.232
DExhibScholarlySkills Chg: During the past academic year (pre) or during the capstone (post) the student exhibited scholarly skills.	.216

Perhaps indicating a concern, correlations show little agreement between students and faculty on whether faculty members are actually encouraging independence. The correlation between the student rating of “My mentor encouraged my independence” and the faculty report that “I encouraged this student to work independently” was only .09. This apparent disconnect is borne out by alumni comments and observations made in the student and faculty focus groups. The low level of agreement suggests that mentor training should include discussion of methods of developing student independence.

Is it important to have students participate in developing or refining their capstone topic?

At all institutions the topic selection process is designed to allow individual students latitude to choose a topic in which they have a significant personal interest – ideally, a subject about which they are passionate. The more choice students felt they had over his/her capstone topics and research questions, the more motivated and positive he/she felt about the project. This did not require, however, that the choice be entirely the student’s. Students who joined a faculty’s research project or were in a themed capstone seminar were able to take a prescribed topic area and choose a sub-topic and research question and feel it was a meaningful choice.

On five point scales, students seem to be relatively happy with the process for topic selection ($m=4.05$), and with the resulting topic, rating their enthusiasm for the topic at the beginning of the capstone with a mean of 4.21. Enthusiasm drops modestly by the end of the capstone to a mean of 4.09.

Although not rising to the level of statistical significance, it is worth pointing out that students in the Natural Sciences gave lower values for their being the origin of the their topic (3.37) and the extent to which they participated in its development (4.11) than students in the Social Sciences (4.05 and 4.26 respectively) and the Humanities (4.21 and 4.42). However, students in the Natural Sciences expressed the greatest satisfaction with the process used to select the topic (4.16, with 4.0 for the Social Sciences and 4.05 for the Humanities).

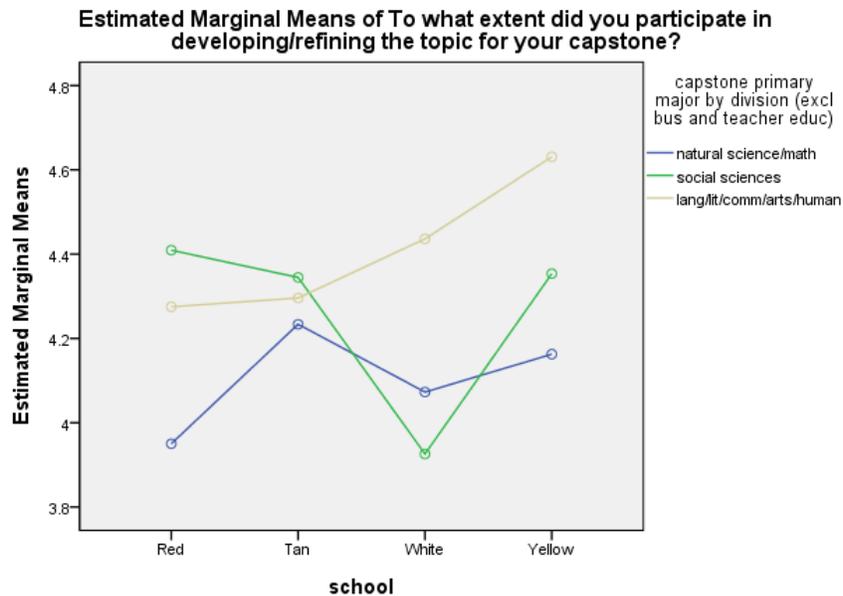
The table below shows the positive and significant correlations between letting the student participate in developing the topic and many favorable scale outcomes. Particularly strong correlations are found for faculty reports of student enthusiasm for the topic and student performance during the capstone. Student scales of performance are also significantly correlated, but not as strongly.

Having noted above the association of student enthusiasm and time-on-task, we would conclude that having the student participate in topic development is also linked with increased time-on-task. Intuitively, the more interested the student is in the topic, the more willing he/she are to devote time to its exploration. Other data suggest that it is fine for mentors to originate the topic for the capstone as long as the student is involved in negotiating its development and can take ownership of the project.

Correlations	PostFac38 To what extent did the student participate in developing / refining his /her capstone topic?
PostStudentTopicMotiv Mentor rating of students enthusiasm for the topic	0.79
PostIntelEngagement Student exhibited good intellectual engagement behaviors.	0.52
PostCrThinkSkills Student exhibited good critical thinking skills.	0.46
PostEffProjectMgt Student exhibited good project management skills.	0.46
PostMentorRapport Mentor's self-rating of good relationship with the student	0.39
PostCommunSkills Student exhibited good communication skills.	0.37
PostMentorInstruction Mentor's self-rating of instructional own helpfulness	0.28
DIntelEngagement Chg: Student exhibited good intellectual engagement behaviors.	0.28
DEffProjectMgt Chg: Student exhibited good project management skills.	0.25
DCrThinkSkills Chg: Student exhibited good critical thinking skills.	0.25
PostRatingAcadAbil Student's self-rating of his/her academic ability.	0.19
DCommunSkills Chg: Student exhibited good communication skills.	0.19
PostCapSuccessful Overall assessment of the capstone as a successful experience.	0.17
PostMultPerspectives Using behaviors showing interest in examining ideas from multiple perspectives	0.17
PostExhibScholarlySkills During the past academic year (pre) or during the capstone (post) the student exhibited scholarly skills.	0.17
PostCapMoreEngaging Rating of the capstone as more or less intellectually engaging than a regular course.	0.16
PostNeedCognLite An abbreviated version of the Need for Cognition scale designed to measure interest in or enjoyment of higher order cognition.	0.13
PostMentorRel Helpful and comfortable relationship with the mentor.	0.12
DMultPerspectives Chg: Using behaviors that exhibit an interest in examining ideas from a multiplicity of perspectives.	0.12
PostCapContDev Rating of the contribution of the capstone to the development of scholarly skills.	0.12
PostResearchOrient Student's self-rating of his/her drive to achieve and persistence.	0.12
DHighOrderCogn Chg: Use of higher order cognitive thinking skills (analyzing, synthesizing, judgments, applying theories).	0.11
PostSatisInstr Satisfaction with instruction.	0.10
DExhibScholarlySkills Chg: During the past academic year (pre) or during the capstone (post) the student exhibited scholarly skills.	0.10
PostProjMgt Exhibiting good project management skills.	0.10

Are capstones in the Natural Sciences more closely aligned with faculty research interests?

Some have speculated that for various reasons, including laboratory and equipment needs, students in the Natural Sciences need to align their capstone topics more closely with the research interests of faculty, and are, consequently, less involved in defining the topic. A GLM paralleling those discussed above showed no significant effects from the academic division or school separately, but showed a significant school*division interaction. Thus, the extent of alignment is affected by varying divisional practices across the four schools, as illustrated in the GLM plot below, where the results for divisions vary by school.



Covariates appearing in the model are evaluated at the following values: College GPA - Start of capstone year = 3.2985

Is a *universal* capstone requirement justified?

Our institutions have made the capstone requirement apply to all students, not just honors students or students in the Natural Sciences, where undergraduate research programs tend to concentrate. The universal requirement appears to be justified by our data, in student and mentor comments, and in our alumni survey results. Although there are some notable differences, the data show remarkable consistency of reports of capstone changes by both students and mentors across academic divisions, GPA levels, and gender, and, generally, that significant gains from the capstone experience can be achieved by all types of students. Moreover, many of the areas of gains seem linked to the unique characteristics of the capstones in comparison to a regular course, as an independently managed, large scale, significant research or creative project. Among the student scales, most showed no significant effects from academic division or GPA. The exceptions are GPA effects for StatusCareerOrient, RatingLeadCollabSkills, and ProjMgt.

Lower GPA students appear to report *higher* gains in ProjMgt, reinforcing the value of capstones for this group. No student or faculty scales showed significant effects from division

alone, but HighOrderCogn, NeedCognLite, EffProjectMgt, IntelEngagement, CrThinkSkills showed a significant effect from the school*division interaction. The interpretation of this is not clear, but apparently institutional approaches to the capstone, which are largely driven at the departmental level, are different enough to yield varying results based on disciplines. Some further comparisons of capstone types by division and across schools might help clarify this.

Looking more closely at GPA differences, it appears from faculty reports that higher GPA students tend to perform better during the capstone as shown by the correlations of the pre-capstone GPA with the faculty measures:

Correlations with pre-capstone GPA	PreCapColGPA College GPA - Start of capstone year
PostCommunSkills Student exhibited good communication skills.	0.50
PostCrThinkSkills Student exhibited good critical thinking skills.	0.50
PostIntelEngagement Student exhibited good intellectual engagement behaviors.	0.49
PostEffProjectMgt Student exhibited good project management skills.	0.48

Consistent with these scale correlations, the capstone grade assigned by the faculty member had a similar correlation with the pre-capstone GPA of 0.57.

That students who perform better academically prior to the capstone would also tend to perform better during the capstone is not surprising. The case for including lower GPA students in a capstone program, however, is that they are able to develop during the capstone on a par with other students; there are positive effect sizes for many of the developmental scales. That students at all GPA levels are achieving growth on a more or less equal basis is evidenced by the comparable effect sizes at various GPA levels, and the low correlations of the pre-capstone GPA with the pre/post difference scores for both the student and faculty scales (statistically significant correlations have been bolded):

Correlations with pre-capstone GPA	PreCapColGPA College GPA - Start of capstone year
DCivicOrient Chg: Orientation toward civic engagement.	0.08
DStatusCareerOrient Chg: Desire to have a prestigious, high paying, and high achieving career.	0.07
DSatisSuppSrv Chg: Satisfaction with academic support services (library, computer, facilities/equipment supporting their major).	0.07
DRatingLeadCollabSkills Chg: Student's self-rating of his/her group collaboration skills.	0.05
DRatingIndepVoice Chg: Student's self-rating of his/her understanding of themselves and others and ability to think on their own.	0.05
DRatingStriver Chg: Student's self-rating of his/her drive to achieve and persistence.	0.04
DResearchOrient Chg: Enjoyment of research.	0.03

Correlations with pre-capstone GPA (continued)	PreCapColGPA College GPA - Start of capstone year
DHighOrderCogn Chg: Use of higher order cognitive thinking skills (analyzing, synthesizing, judgments, applying theories).	0.02
DRatingAcadAbil Chg: Student's self-rating of his/her academic ability.	0.02
DMultiPerspectives Chg: Using behaviors that exhibit an interest in examining ideas from a multiplicity of perspectives.	0.02
DSatisInstr Chg: Satisfaction with instruction.	0.01
DNeedCognLite Chg: An abbreviated version of the Need for Cognition scale designed to measure interest in or enjoyment of higher order cognition.	-0.01
DAdvDeg Chg: % planning advanced degree	-0.01
DExhibScholarlySkills Chg: During the past academic year (pre) or during the capstone (post) the student exhibited scholarly skills.	-0.04
DProjMgt Chg: Exhibiting good project management skills.	-0.07

The negative significant correlation with DProjMgt indicates the possibility that lower GPA students perform better in developing project management skills.

A caveat in regard to universality is that there were several faculty comments about the frustrations of mentoring a capstone for students who were unmotivated or had poor writing/communication skills, and including lower GPA students in a capstone requirement, to the extent lower GPAs are associated with lack of motivation or writing skill, may add to the faculty mentoring burden.

Does student socio-economic background affect results?

No evidence emerged that the student ratings for the capstone as successful or its contribution to development were affected by socio-economic background variables that included parental education levels or financial aid measures of need, grant aid, or loan aid.

Is the capstone experience different for double majors than single majors?

In our database of capstones almost 39% of the students were double majors. This group shows statistically significant higher means on multiple perspectives, self-ratings of academic ability, orientation toward research, and use of high order cognition during the capstone. They were less likely to expect a good capstone or find the capstone more engaging than a regular course. They had a smaller decline in multiple perspectives and a smaller increase in reporting they exhibited good project management compared to single-major students.

Does the capstone grade correlate with students' self-ratings of a successful capstone or Development from the capstone?

Not as highly as might be expected. After converting grades to a 4-point scale, the correlation of grades assigned with student estimates of success and development were a fairly modest .23 and .15, respectively.

This could be the result of different understandings of or perspectives on the capstone's impact; mentors expect integration and other higher order skills, while students see the quality of the personal relationship they had with their mentor and are pleased with their ability to complete a daunting project.

WHAT ARE THE IMPLICATIONS FOR GOOD PRACTICE?

Here we describe some general implications for the practice of capstones based on the discussion above, supplemented by the collective wisdom of the faculty and administrators participating in the project conferences, and comments from students and mentors. Before listing recommendations, we look below at several preliminary questions. Items are not necessarily in order of perceived importance.

What are the characteristics of capstone projects that can lead to the most benefit for the student?

- Large scale and challenging, but achievable given the student's background and the time and resources available; generates data the student can present, not simply be cookbook; have built-in difficulties that can be faced by the student after building some confidence; be multifaceted
- Requires project and time management (planning, organization, sustained effort)
- Of personal interest to the student, something they help select and can own
- Generates knowledge (new overall or for student)
- Includes a public presentation
- Requires significant writing in the style of discipline
- Requires core liberal arts skills – close reading, writing, critical thinking, quantitative reasoning
- Uses disciplinary methods, requires consideration of theoretical aspects of the discipline, requires critical thinking in the style of the discipline
- Provides the opportunity for peer interaction around common problems or to give peer reactions/feedback
- Requires placing the project in a broad context, e.g., a literature search, consideration of the points of view of others, taking multiple perspectives into account, integrating ideas from other disciplines
- Includes a reflective component on the capstone's contribution to the student and to the discipline or society

Again, these are not absolutes applicable to all capstones, and are not currently emphasized equally in all our programs. The suggestions to include a greater emphasis on integration, multiple perspectives, and reflection came from a sense that these are lacking in our current programs.

What makes for good preparation for a capstone?

- Core liberal arts skills - writing/presenting, critical thinking, creative thinking, general quantitative reasoning

- Statistics, advanced quantitative skills, and Lab skills/technical skill development as needed for the discipline
- Disciplinary courses in general
- Theoretical grounding in the discipline, not just facts
- Embedded research/inquiry experiences
- Preparation from coursework in the major, junior seminar or methods courses, research- or writing-intensive courses
- Literature review experience
- Prior project management experiences that develop planning and organization skills
- Building for independence in thought and action

What are general characteristics of good mentoring/duties of mentors?

- Rapport with the student; cultivating a relationship with student that is collegial and encouraging; demonstrating an interest in the student's topic and the student's success
- Help defining the project's scope and providing a vision for what the project should do for the student and encouraging the student to take advantage of the opportunity
- Requiring independence while providing scaffolding for deadlines, objectives, and expertise; providing the right amount of independence while not letting the student flounder
- Availability and providing timely and constructive feedback
- Modeling scholarly behavior, disciplinary practice
- Assisting with getting resources: finances, materials, IRB approvals, contacts
- Being aware of institutional policies and support resources so as to deal appropriately with unmotivated, underperforming or underprepared students, or students who fall behind due to illness or family problems or experience inordinate stress
- If possible, encouraging or structuring peer interactions for mutual support or collaboration

What are the general characteristics of a good institutional structure?

- Making the rationale for the program explicit for both students and faculty
- An academic curriculum that prepares students for the capstone. Comments from mentors noted the importance of writing skills and a particular need to ground majors more firmly in the theory of the discipline.
- In most majors, a course designed as specific preparation for the capstone, covering such areas as required research methods, project management issues, human subject/IRB ethical considerations, literature searches, etc. and that includes helping the student select their project topic and prepare a proposal
- Structures that promote student input/choice in the selection of the topic and mentor
- 1:1 mentoring, but not necessarily exclusively
- Defining what is expected of mentors; mentor training; mentor handbook
- Clear policies – for mentor and students, and especially for double majors

- Mentoring role valued by the institution and a component of retention, tenure, and promotion decisions
- Equitable and adequate workload credit for faculty
- Equitable credit hours across majors and clear expectations for students
- Financial support for individual students through some regularized process (e.g. grant applications)
- Adequate support from support services - library, reading/writing centers, ITS , etc.
- Public recognition and celebration of successful projects
- Secondary review of the capstone product, such as through a second reader or oral presentation attended by faculty in the capstone department

SECTION 4: DISCUSSION OF PROJECT RESEARCH QUESTIONS AND IMPLICATIONS

The findings presented in earlier sections are summarized here in the context of the project's questions. Some of the questions were revised and others added as we gained better understanding of our interests through the creation of the instruments used in the project and through data collection and analysis.

What is the impact of the capstone experience on outcomes leading to lifelong learning?

The project proposal identified three outcomes to explore in order to assess the degree to which a universal capstone contributes to lifelong learning: 1) being able to plan and conduct an intellectually demanding project; 2) developing an understanding of one's self and one's interests and capabilities; and 3) understanding the nature of research and how knowledge is constructed and connected.

Still close to the completion of their capstones, most seniors can describe what they believe they gained from their capstone experience, but, understandably, they do not yet have a clear or complete understanding of how that experience will benefit them in the future. Reaching this self-understanding requires some time and distance from the actual project. Nonetheless, it is clear that the capstone had a positive impact on many self-understanding outcomes, with most students expressing a sense of accomplishment, a better understanding of their interests and abilities, and growth in personal and intellectual self-confidence.

Virtually all students and faculty participants identified planning and conducting a demanding project as a primary outcome of the capstone experience. Students on all four campuses produced a similar response to the question "What have you learned from your capstone?", identifying: a) doing original research; b) designing one's own project; c) being self-sufficient and independent; d) thinking creatively and critically, solving problems and persevering; and, e) practicing effective time management and organization. Faculty identified a similar list. These lists align with the three outcomes that the project sought to explore.

Senior and mentor data support these observations. The means for the student scales and the post-capstone comments indicate students made gains in academic skills (including writing and oral communication and critical thinking) and project management skills (including time management, planning, organizing), perseverance in the face of obstacles, developing a better understanding of their own abilities and interests, developing an empowering sense of academic self-confidence and achievement, and developing an increased enjoyment of rigorous intellectual engagement, including doing research.

In contrast, project data does not show an increase in civic mindedness during the capstone, or increased use, compared to prior coursework, of multiple perspectives, considering ideas or concepts from other courses, or generally considering the perspectives of others. Also, although several students noted gaining knowledge of their project topic as a benefit, it was the general development items noted above that were predominantly cited by students, rather than gaining disciplinary knowledge.

These results are highly consistent for student groups across academic division, GPA level, socio-economic status, and gender, supporting the use of capstones as a universal curricular component that can benefit all students. Results vary somewhat by factors that transcend

these student groups, such as credit hour effort, duration of project, student time-on-task, and individual student motivation.

The project shed less light on the third set of outcomes, “understanding the nature of research and how knowledge is constructed.” Most students noted the value of “practicing their discipline.” For example, that their science courses “were fake science, while my [capstone] research was real science.” Yet students generally did not talk about increasing their understanding of how things are known, the interrelationship of knowledge, or valuing different points of view.

It seems likely that the combination of working on a fairly narrow question in the student’s discipline, the new experience of having to work independently on a large project, and the high stakes of failure focus the student’s attention on the details of successfully completing the project and leaving little time and perhaps little inclination to reflect on the broader considerations of the relationships between the capstone and the curricular and extra-curricular activities prior to the capstone.

While it is not altogether surprising that seniors are less articulate about learning outcomes and the nature of research and knowledge than are faculty, it was striking how little some seniors seemed to know about the educational rationale for the senior capstone, often with little understanding of the value, importance, and benefits of the capstone, and consequently why the college requires the capstone for all students. Faculty at all four institutions were quite articulate and clear about these matters.

Responses from alumni two, five, and ten years out are positive and focus on many of the growth areas seniors identified. Alumni rated the contribution of their senior capstone to their development highly in terms of learning effectively on their own; the ability to think critically and analytically; developing greater skill in interpreting data; learning to manage a large project; and, developing confidence in their abilities. More so than seniors, alumni felt they gained in their ability to think creatively and to integrate ideas from multiple disciplines. They felt that the capstone was a positive influence on their intellectual growth and their interest in ideas, and that it was a positive influence on personal growth, attitudes, and values.

The conclusion is that the unique nature of the capstone project – the complexity and scale, long duration, degree of independence and self-management required – contributes to many, but not all, of the outcomes that lead to lifelong learning.

What are the costs of the capstone for the student?

Seniors and alumni agreed that the capstone was more engaging than a regular course, but it was also more challenging. Combined with the independence expected of the capstone, this greater challenge can be a source of stress. 84% of seniors indicated that their capstone was more stressful than a regular course. Higher GPA students saw this as an intellectual challenge and an opportunity to prove themselves, while lower GPA students were more likely to be concerned about being able to sufficiently meet the challenge in order to pass.

As a graduation requirement, the capstone has high stakes. Although failing a course in the major would in most cases also prevent a student from graduating, seniors seemed to feel the consequences of a failed capstone more acutely.

Other sources of stress originated in the specific circumstances of a student's project and its implementation: difficulty getting resources, equipment failures, confusion about what was expected, and an unsatisfactory student-mentor relationship were mentioned by students.

There were 14 capstones, about 1%, where the student comments appeared to report extreme or debilitating stress and another 2% reported a level of stress high enough to significantly interfere with other courses or activities. But in many cases when stress was mentioned by students as a negative aspect of their capstone experience, the students added a disclaimer that it was worth it and a natural part of the experience, and that overcoming the challenge was a source of pride. This view is supported by the results of a survey question: when asked if "Overall, I had good capstone experience," the majority (84%) agreed or strongly agreed, while only 5% disagreed or strongly disagreed.

There are several opportunity costs. An obvious tradeoff is the loss of the opportunity to take equivalent credits in other courses, particularly in the major. The data suggest that the capstone experience provides (or includes) developmental benefits that are different from most standard courses. This still leaves room for debate about how long the capstone experience needs to be, in terms of credit hours, to achieve the most benefit with the least disruption of other goals of the curriculum or co-curriculum. The combination of greater challenge and independence impacts workload, with seniors reporting spending just over 14 hours per week on their capstone. Some students felt that this heavy workload interfered with their ability to spend time on other courses, to participate in extracurricular activities, and to apply for jobs and graduate school. However, data from alumni suggests that the impact is minimal. It is clear, however, that preparation for the capstone and the capstone itself can complicate taking advantage of study abroad opportunities.

For the most part, students (and faculty mentors) feel that the benefits outweigh the costs and that the capstone is valuable and should continue to be universally required.

How does the capstone experience benefit the faculty mentor? What are the costs?

Faculty mentors on each campus have a shared sense of the purpose of their capstone, the responsibilities of the mentor, and what a successful capstone experience looks like for the student.

In the tradition of the true teacher-scholar, a significant component of the identity of faculty members who choose to teach at a liberal arts college is their love of working with students. On each campus mentors stated some version of the following sentiment: small liberal arts colleges with strong (and universal) undergraduate research capstones allow them to balance their dual passion for research and teaching while working closely with students. It is no surprise, then, that faculty participants on all four campuses were largely positive about serving as capstone advisors, some claiming it as their "favorite" or "most enjoyable" part of their job. Mentoring capstones involves considerable personal investment in the student-mentor relationship and the outcomes of individual student's projects. Consequently, the main benefit for mentors is tied to the sense of satisfaction that comes when this relationship is productive.

Faculty on each campus identified similar benefits from capstone mentoring, including:

- Knowing individual students well, as a fellow scholar (co-learners) and often as a lifelong friend and mentor.
- Observing student learning and sharing in “aha” moments of discovery, and working on a project with a successful outcome.
- Learning something new in their field, staying excited about research, and sometimes furthering one’s own research.
- Having collegial conversations and relationships with students.

Faculty members were equally consistent in identifying the negatives of mentoring capstones, including:

- The additional work and the emotional toll that accompanies mentoring students who are poorly prepared, unmotivated, and/or unresponsive to feedback. The consequences of failing a student magnify this.
- Generally, the amount of work that goes into advising. As indicated above, this increases when the student needs extra attention. Project topics outside the mentor’s area of expertise, and in some cases even familiarity, add to the workload. The degree to which the capstone topic aligns with the mentor’s area of expertise varies by school and academic division. For two schools the alignment appeared greater for the natural sciences. Although most faculty members appreciate the workload compensation arrangement in the form of course release, many feel the allotment ratios are inadequate.
- Time lost from research and teaching. An underlying issue is faculty identity. The heavy obligations of capstone mentoring sometimes bring with them a burden of confusion about what’s being valued and prioritized at the faculty member’s institution. What are faculty members’ duties? What is valued by the institution and outside it? What will contribute to a successful career? Generally, this issue was more prominent for junior faculty members who were not yet tenured and still finding their way with mentoring capstones (and undergraduate research).
- Comments about co-advising (double majors or students who also had advisors outside their home institution) were almost all negative.

While faculty mentors were very clear about the downsides of advising capstones, these negatives were outweighed by the positives, and mentors were nearly unanimous about the capstone remaining a universal requirement and that all students can benefit from it, if not equally.

How do support personnel perceive and experience the capstone?

While students and faculty advisors are at the center of an intense lengthy educational experience, personnel in departments that support capstone students experience the capstone in a more limited and often indirect way: assisting with using a database, planning an organizational strategy, helping with writing. Where faculty experience a few capstone projects as inside participants, support personnel get an outsider’s glimpse or two of many projects.

Yet support personnel at each campus seemed well informed about the capstone program and acutely aware of the student capstone experience. They described the campus capstone

cultures much like the students did. Serving more as consultants to the students, support personnel had similar observations and recommendations: 1) they saw the variability (between departments) of capstone projects and processes, and therefore suggested better department capstone information and more uniformity among departments; 2) though they feel their work with the capstone program is generally appreciated and valued by students and faculty, much of what they do is less visible, especially to academic administrators; 3) they feel that currently they are able to satisfy the needs and demands of the capstone program, but they are at the limits of their capacity.

What are the similarities and the differences in how our capstone programs are formulated?

The four programs have more in common than they have differences, but some of those differences appear to be significant in driving the benefits described in Section 3.

The capstones on all four campuses are a universal requirement, but departments have a fair amount of latitude in the implementation; the general education curriculum and department curricula are designed to prepare students for their capstone and the great majority of departments have a methods, theory, or junior seminar course that students complete before beginning their capstone; students have significant say in the selection of their project topic and have some influence over the selection of their mentor. The predominant, but not universal, model on the four campuses is a one-on-one mentored experience in which the student is expected to take responsibility for the project's topic, planning, and execution. These characteristics make the capstone a more substantial project than anything students will have done in their regular courses. These common formulations are sufficient to produce a similar experience for students and faculty across the four institutions.

There are some important differences.

- *Types of projects.* Red had the least variation, as all students complete a two semester thesis or creative project requiring original research and advanced writing. Yellow's capstone is almost as uniform; research may be original or literature based. At Tan, students write a traditional original research thesis, write a literature based research thesis, develop case studies, engage in simulations, and participate in an internship. The greatest difference is at White where the capstone project may be an original research thesis, a literature based thesis, a public performance or creative work, a student-teaching portfolio, or a comprehensive exam. In particular, the teaching portfolio and the comprehensive exam have few of the characteristics of the mentored student-driven capstones. The project's design did not support looking for evidence that would tell us if portfolio or comprehensive exam experiences are more or less or differently beneficial. However, there is circumstantial evidence, such as lower scores on many indices for White, that these experiences are less beneficial.
- *Duration and scale of projects.* None of the institutions prescribe a universal or standard size for the project, though at Red all projects are two semesters (30 weeks). Projects at Yellow range from four to eight credit hours, with most being four credit hours preceded by a two credit course in which the student researches and prepares a project proposal (22 weeks). At Tan, projects range from three to nine credit hours, with most being three

(ten weeks). All projects at White are four credit hours (15 weeks). Generally, the number of credits dictates the size and scope of the project.

- *Teaching credit.* At White, a course release is given for every twelve students mentored. Yellow has a point system for advising that yields a course release for every eleven students. Red gives a course release for every five students mentored, however this is a two-semester commitment. Course releases at Tan are most variable, with each department negotiating an arrangement with the dean.
- *Oral presentation component.* Red and Yellow require all students to pass an oral defense to complete the capstone; many departments at White and Tan require a defense or some type of presentation.
- *Reflection as a formal component of the capstone.* Only Tan has a formal written reflection component in the capstone. What this looks like varies by department.

Despite these differences, the same positive and negative themes emerged in student comments. It appears that the main benefits can be achieved through a wide variety of capstone structures, although the benefits will vary in extent. For instance, project management benefits, which are seen at all four institutions, are most often cited by students from Red, which has the largest universal credit requirement at eight credits spanning the entire senior year.

That the same positive and negative themes occurred across the four participating campuses is consistent with the interpretation that capstones “work” because they engage a basic set of good practices – high expectations, time on task, close student faculty interaction, and challenging work. If this is the case, one would expect many of the structural differences across campuses that are the result of so much faculty effort really aren’t important to the impact of the capstone, so long as the hard work, interactions, high expectations, etc. persist. More radically, this would also imply that a powerful service learning project, internship, or other senior work that involves these good practices may have the same impact as a capstone.

What resources (programs, structures, and personnel) are our colleges providing to support the capstone programs?

The most significant resource required to support mentored capstones is faculty time. On three of the campuses this comes in the form of course releases and on the fourth as either a course release or a stipend. The ratio of students to course release on each campus is derived from the equivalent effort that a faculty member would put into a regular course. However, faculty on all campuses felt that the work required to mentor seniors was greater than the work required to reach a course with the same number of students. Mentors report spending almost three hours per week working on all aspects of a student’s capstone. At Yellow and White where 11 and 12 students, respectively, equal a course release, that means upwards of 36 hours per week spent on mentoring, which is much greater than the time that would be spent teaching a regular course of 12 students. Some departments have consequently moved to seminar and group advising arrangements, reluctantly abandoning the pure one-on-one advising approach.

Students believe that the regular individual meetings with the advisor are critical, and that the advisor/ student ratio should remain small.

All campuses also provide support through writing, learning, and math centers. Of these, writing centers are most likely to see increased workload deriving from seniors working on their capstones. Although faculty comments suggested that writing was a problem for some students, there were few student comments about the writing center. Faculty noted that students seem to be reluctant to use reading/writing centers because students generally perceive such support to be geared toward first-year students. Working with students with poor writing skills was among the negative aspects of capstones identified by mentors.

As with writing centers, the library and information/instructional technology department see increased usage deriving from capstones. Student perception of the library, computer, and departmental facilities/services saw a decline pre- to post-capstone. It is not clear if this is because these services are understaffed, not sufficiently adapted to supporting the capstone, or if students' prior experience using these resources was insufficient to meet the demands of their capstone.

Most campuses have a special fund to support capstone projects. In some cases, access to the fund is competitive through a grant process. Mentors and students on all campuses recommended that more money be available to support individual projects. Some departments have a separate budget line to purchase hardware, software, or consumable resources to support their seniors.

Some campuses provide support for a rising senior to do capstone-related work with a mentor over the summer.

Some campuses provide funds for seniors to present their work at conferences.

Some of the campuses have a campus-wide celebration during which seniors are invited to share their work through presentations and posters. On one campus, classes are canceled to allow all students and faculty to attend. On other campuses, the celebration is department-based, but not all departments participate.

What conditions and practices result in a positive capstone experience? What aspects of the capstone experience that lead to educational benefits are unique to or are more prominent in the capstone than in a regular course?

The following describes those capstone characteristics that our data suggest lead to the best results for students.

Preparation

Students felt that writing-intensive courses and methods courses in the first three years prepared them well with the research and writing skills needed for the capstone project. Clearly, though, writing remains a problem for a significant number of students.

Students also strongly endorsed the junior seminar, particularly when it included choosing the capstone topic, shaping the research question, and presenting a proposal. Students believed that getting started on the project can be particularly difficult to do independently.

Student choice of topic

The more choice a student felt she/he had over selection of the capstone topic and research question, the more motivated and positive he/she felt about the project. This did not require, however, that the choice be entirely the student's: students who joined a faculty's research project or were in a themed capstone seminar were able to take a prescribed topic area and choose a sub-topic and research question and feel it was a meaningful choice.

Perceptions of the relevance and usefulness of the capstone

Those students who believed that their project was relevant (it mattered and was important to them) and useful (would help them in the future) were more motivated and positive. The few student participants on each campus who: a) did not plan graduate study or employment in their field of study (academic discipline), and b) did not appreciate the broad liberal arts skills they were acquiring or strengthening, viewed the project as "just another paper" or "just a graduation requirement," and did not have a positive experience. Focused only on the content of the project, they saw little value in "learning so much about something I will never use." Also important was having a sense of practicing (not studying) the discipline in a way that provided an opportunity to become an "expert" on a topic.

Scale and challenge

The project should be large in scale and/or duration providing a high level of challenge, but be within the student's ability. There should be high institutional expectations for effort, time-on-task, and performance. The project should result in something tangible – a significant paper, thesis, or performance that integrates core liberal arts skills of writing, and creative and critical thinking. Having to give a presentation of the project's results is also important.

The student/advisor relationship

Students suggested that they could have a successful project without a strong advisor relationship, but it was not likely to be a positive capstone experience. Students also suggested that structure and definition at the beginning of the relationship (e.g., regular scheduled meetings, explicit discussion of "how we will work together") is useful.

Motivated students, and advisors who expected and encouraged student initiative, responsibility, and ownership

Faculty thought that although students needed to bring these qualities to the project, they could advise and support students in ways that fostered or engendered them. There is a delicate balance between providing too much and too little independence. Many areas of growth are tied to having to fight through difficulties on one's own.

Healthy students (physically and emotionally)

The demands of the capstone project require healthy students. This is primarily the student's responsibility, but faculty and staff can provide support and structure for those at risk and in need.

Students who reported having a negative experience most frequently commented on having a topic they were not interested in or lost interest in, a mentor who was not supportive and/or not helpful (e.g., uninterested in the student's topic, missed meetings, gave poor advice, did

not provide timely feedback, particularly on thesis drafts), or poor time management skills making it difficult to meet deadline.

What policy or structural concerns did the project uncover?

While the capstones on the four campuses clearly are strong and result in student benefits, the project identified areas where improvements should be considered.

Students

Workload

The capstone is demanding of all students and for the most part students accept this with equanimity. However, there is a perception among some students that there is a lack of uniformity in the workload expected of students across departments or project options (e.g., thesis, performance, comprehensive exam). Departmental latitude in structuring capstones as appropriate to the discipline is essential, but uniformity across campus is also important. The tension between these two concerns can be difficult to resolve.

The timing and workload demands of the capstone make it more challenging for students to take advantage of study abroad opportunities. One solution is to begin working with students earlier to help them plan their four year course of study to incorporate study abroad. Students also feel that the demands of the capstone make it more difficult to find time to apply for graduate school or jobs. Encouraging students to meet earlier with their career services department, perhaps as part of a course taken in the junior year, would help seniors plan and prepare. This could be combined with identifying a specific period during the senior year when students are asked to put together their materials (e.g., application letters, resumes, etc.). Faculty and career services staff would provide support sessions during this period, and the experience of going through it together would give seniors an opportunity to help each other.

Stress

The high expectations and time requirements of the capstone result in student stress. While reasonable stress from the challenge of the capstone is part of the growth equation, an inflated sense of the challenge can occasionally be debilitating. It is important to monitor students to identify those who will feel the stress more acutely, and whose health and academic performance overall may suffer. Helping mentors to identify the signs could be part of mentor training.

Writing and Project Management

Mentors report frustration dealing with a significant minority of students who are not fully prepared for the capstone, notably those who do not have sufficient writing or project management skills.

Many students are challenged by the writing component of capstones, but are reluctant to use writing centers, which are perceived to be designed for first-year students. Support services specifically targeted for seniors and capstone projects, possibly through reading/writing centers, might be helpful in dealing with those students, while reserving mentor time for other matters.

Students get little exposure to project management prior to their capstone. This fact, coupled with the real need for project management skills, likely accounts for the tremendous growth seen in this area. It seems clear from the data that students are developing skills in multiple areas during the capstone. Developing better project management skills prior to the capstone should give students more time to devote to other challenging aspects of the experience and could result in greater, or possibly just different, growth.

Group as well as individual meetings

The student-mentor relationship is an important component of a positive capstone experience. Good practices include defining the expectations for mentors and providing training, such as serving as second reader. Project data suggest that strictly one-on-one mentoring may not be the only viable model, and that best practices may include significant one-on-one mentoring in conjunction with periodic group meetings of a mentor's students. In addition to potentially lessening the mentoring workload, several comments referred to the value of such group meetings in providing support and encouragement from other students.

Reflection

Many of the lifelong learning outcomes require the student's awareness of his/her strengths, weakness, approach to learning, etc. Gaining these insights requires time and purposeful reflection. While one of our campuses includes a reflective component as a requirement of the post-capstone work, how this is done varies by department and students have little or no exposure to such reflection in earlier years. On the other campuses there is no required reflection component. It would be valuable to help students develop the ability to critically self-reflect. This should begin in the first year.

Capstone Purpose

Surprisingly, although the capstone is a significant component of a student's experience on our campuses, some students don't have a good sense of the purpose of the capstone or its role in their education. Working with students on critical self-reflection and being explicit about the expected outcomes of the capstone should give students not just a better understanding of the capstone's purpose, but why and how they should prepare for it, and how they can leverage that experience following graduation.

The Capstone and Liberal Arts Outcomes

It was surprising to us that valuing and incorporating different points of view (multiple perspectives) showed a decline pre- to post-capstone. One would expect that this attribute would be a necessary element of any substantial capstone project. It may be that the wording of this item produced a meaning for students different from that intended. But given that incorporating different points of view is an important liberal arts outcome, this apparently anomalous result should receive further consideration on each campus. Additionally, we expected that students would develop a better understanding of how things are known and the interrelationship of knowledge. Perhaps this did occur and our instruments did not capture it. Also possible is that since this kind of understanding is quite abstract, it may take time and distance from the capstone to see the connection. It appears that gaining these insights is expected as a natural byproduct of coursework and the capstone. However, these are

also cherished liberal arts outcomes and our campuses should consider if something more intentional should be done to help students see the connections.

Mentors

Workload

Mentors were nearly unanimous in their support of the capstone as a universal requirement, which suggests that they recognize and accept the demands this places on them. However, many feel that the work required to mentor a group of students in their capstone is not balanced by the course release they receive. On the one campus where a faculty member can receive a stipend instead, the stipend is not the equivalent of a single course salary-wise. However, some departments on that campus are too large to be able to provide course releases, forcing faculty into the stipend alternative. There is also a perceived lack of uniformity in workload release across departments on some campuses. These are not easy problems to solve.

Inter-departmental Capstones

Capstones that cross departments were identified by students and faculty as problematic. In some cases expectations of the student were not clear, and in other cases it was mentoring responsibilities. Sometimes departmental requirements clash in ways that make it difficult for the student to find a single topic that will satisfy both departments; often compromises are made that leave the student and/or a mentor feeling the experience was diminished.

Some mentors questioned the ability of students, particularly weaker students, to do integrated multiple-major capstones, especially if they require a theoretical understanding in more than one discipline. Other mentors praised capstones that were successful in integrating majors. However, it is clear that inter-departmental capstones are more problematic than single department capstones.

Complicating finding a solution to these problems is the underlying issue of the institutional purpose of the capstone versus departmental control over what the capstone looks like. Each campus would benefit from considering this question and laying out clear expectations for how inter-departmental capstones should work.

Mentor Training and Evaluation

The mentor plays a pivotal role in creating a successful capstone experience, so it is strange that none of the campuses has a guide for capstone mentoring or mentor training. Based on student comments, mentor training materials should include:

- a review of institutional policies and guidelines for capstones
- explicit discussion of the institutionally established goals of the capstone experience for students
- institutional expectations for capstone mentors, and what students say about the mentoring relationship
- suggestions or criteria for designing a capstone project that will meet the intended goals for student development
- methods for working with the student to scale the project for the time available and the student's capabilities

- ways of scaffolding for independence: providing students with appropriate freedom and challenge, while providing enough structure to avoid floundering
- strategies for dealing with unmotivated, unresponsive, or disorganized students (the most common mentor complaint)
- ideas for dealing with multiple advisees: the options, pros and cons of structures like classes, seminars and group meetings

Equally surprising is that there is little formal evaluation of capstone mentoring either to improve the quality of mentoring or for retention, tenure, or promotion. The creation of a mentor manual will make explicit what is expected and could be the basis for designing a system for evaluating mentors.

A related issue is using visiting and first-year tenure track faculty as mentors. The lack of experience coupled with only informal guidance on how to mentor can lead to a disastrous capstone experience. Comments from students suggest that these faculty members are most likely not to know the department's guidelines, not know how to work with *undergraduates* in a one-on-one mentored environment, and, particularly for visiting faculty who are thinking about getting their next post, are less likely to be interested in the student's success. Avoiding the use of visiting and first year faculty may be difficult, but ensuring that they are mentored and supervised should not.

SECTION 5: THOUGHTS ON CONDUCTING A MULTI-INSTITUTION ASSESSMENT PROJECT

This project was the first multi-institution effort for many of the participants. Consequently there was a fair bit of learning along the way, especially for the project directors. Here we describe some of the lessons we learned that have general applicability to multi-institution assessment-based projects.

PROJECT GOALS

Maintaining the level of effort needed to sustain a project over multiple years can be a challenge. Helping project participants see how the project is relevant to the interests of each campus is essential to having meaningful and sustained participation.

Provide a clear, written statement that is agreed upon by the participating institutions covering

- What the project is to accomplish, with a description of what success and failure look like. Seek faculty buy-in through presentation to relevant committees, department chairs, the faculty as a whole, and students.
- Consensus definitions for terms that will be used repeatedly throughout the study, and buzz phrases that tend to be used casually without realizing that those phrases can mean different things (and be loaded with different baggage) at different institutions.

At the same time, an insight gained toward the end of our project is that there is a tendency to privilege local practice as essential and unchangeable. One of the great values of this kind of project is that it leads administrators, faculty, and students to this conclusion, and from that can encourage them to interrogate their own, previously unchallenged, assumptions about the local program.

PROJECT PLANNING

A planning period can be instrumental in clarifying positions and in resolving differences, and it is very helpful to meet your counterparts from the other campuses. Holding a planning meeting requires careful work beforehand so that the time together at this meeting is productive. In particular, ask the planning meeting participants to think about project issues prior to the meeting.

Each campus should consult the relevant offices and committees about the project's goals and its implementation. Given the strategic significance of our project, it was important to engage each institution's chief academic officer and president and to have their public support. In some cases administrative or committee approval may be needed; at a minimum it is important to let relevant campus committees know about the project.

DATA COLLECTION, ANALYSIS, AND SHARING

It can be difficult at the beginning of a project to determine what kind of data and how much of it is to be collected. We spent a lot of time considering this question and struggled in finding the right balance between asking enough questions on our senior and mentor surveys to get the data we felt we needed while producing surveys that weren't so long that we risked having low participation. As more issues were raised about our project questions (an occupational hazard

for academics!), there was a tendency to respond by adding more items to our survey instruments. This can quickly push the survey completion time beyond the tolerance level of students and faculty. Additionally, an expected aspect of a multi-institution project is that each institution will have its own set of interests to explore which can lead to more questions, some of which may not have value across all participating institutions. Having focused research questions provides a brake on unrestrained growth.

It is debatable whether we collected more data than we needed. The scales produced by the factor analysis turned out to be very useful and the types of questions we asked covered our research questions well. The high reliabilities of many of the scales, however, indicate that in many cases we could have reduced the number of questions and still had usable scales. So from a technical point of view, our surveys were longer than they needed to be, but this is not something we could have known in advance. We collected two years of senior-mentor data. The second year mostly confirmed the first year's results at the level of our total aggregated data, so a less detailed study might have stopped after the first year. Two years of data, however, gave us the statistical power we needed to look at breakdowns by student subgroups and gave us a wider perspective from the student and mentor comments.

There is consensus that our collection of alumni data could have been better. We decided to use the general purpose alumni survey developed by HEDS in conjunction with supplemental question about capstones so that we could use their administrative and processing structures, get comparative peer data, and to use the survey both for general institutional purposes and for our capstone project. In retrospect, an alumni survey only about capstones, being shorter and of clearer purpose, would have given us more complete data by allowing more questions and increasing participation rates, which were disappointingly low. It would also have helped our project to interview alumni who responded as seniors during our first year of surveys to revisit their impressions of the capstone after starting their careers or entering graduate school. In particular, would those who were not positive about the experience have a different opinion? Would those who reported it was a terrific experience, still be as enthusiastic?

With regard to our numerical analysis, the great quantity of data resulted in formidable technical problems in assembling, reducing, and analyzing the data. The use of factor analysis was a good beginning in reducing the data to a small number of scales. The use of scales both clarified key concepts and smoothed out some of the noise in the component question responses. SPSS was able to identify statistically significant differences in the means of our scales for pre/post changes and between student groups, but it was only in the second year that an "effect size" measure was computed using Excel to add a measure of practical significance. Consequently, time was wasted before we were able to focus on the differences that were truly meaningful. Also, it was late in our analysis that the predictive models for our scales were computed that combined all our key subgroup variables simultaneously so we could consider interactions of, for instance, school and academic division. In summary, for similar projects, we recommend an analysis plan that includes the use of factor analysis, computing both statistical significance and effect sizes for differences, and, once key variables affecting the scales are identified or as guided by the research questions, using regression or general lineal modeling techniques to tease out interactions among the key variables.

With regard to the analysis of the open ended comments, simply reading the comments carefully is certainly a good start and will yield valuable information, but counting occurrences of topical units, although, time-consuming, is helpful to properly identify the key themes. Complementing the numerical analysis with textual analysis of the comments added significantly to the overall picture we obtained of our capstone programs.

Making sense of the data requires personnel with expertise in the analysis of the kinds of data collected. This can be very time-consuming, so if it is expected that the project will generate a fair bit of data, include a data analyst in the budget. Involving the institutional research offices in our project was critical for their knowledge of data elements and their ability to obtain that data from institutional records, as well as to conduct the surveys and assemble the data for our databases.

Decide what project data will be shared and with whom. Our project generated data that each campus considered to be sensitive (areas where our capstones did not produce good results or where one campus did better than another). A Data Sharing Agreement was created that specified how the data were to be used in the context of the project's purpose and who within the project and on each campus could have access to the data and under what circumstances. The use of colors in this report to identify the participating campuses reflects this sensitivity.

Consider how the project's work can be integrated into existing campus assessment structures.

METHODOLOGY

Describe and make sure there is agreement on how the project will meet its goals. Be aware of the validity of the methods chosen; understand their limitations. Keep in mind that the level of validity required to make this kind of project worthwhile need not be as rigorous as faculty members require in their academic research. This was a point of contention on some campuses where there were faculty and administrators who felt that the project's value was diminished because the project's methodology did not rise to the standard of social science research studies. This attitude damaged the project's status on those campuses.

Online surveys tools such as SurveyMonkey can be very useful in collecting data, but this requires some expertise and, at peak times, can be very time-consuming.

Using outside personnel to run focus groups is a helpful way to provide some measure of anonymity to participants, who can be more candid, and to provide consistency across campuses. Our project used Teagle Scholars through Wabash's Center of Inquiry in the Liberal Arts.

INSTITUTIONAL RESEARCH BOARDS

In a multi-institution study, meeting the requirements of the various IRBs can be a problem. Early contact with the IRB chairs can be helpful to review the overall project, and when preliminary versions of surveys and methods are available. Many problems can be avoided by constructing a master set of documents that address IRB issues, are uniform for all campuses, and that can be appended to all IRB approval submissions.

Particularly helpful is a statement of understanding about research methods and practices that affects confidentiality and anonymity of survey or focus group participants and the security of data. In addition to avoiding duplication of effort, this avoids later confusion as to what was approved.

PROJECT ORGANIZATION

It is critical to have project leaders who possess good leadership, communication, and organizational skills, and are really dedicated to the project, particularly since it is likely that they will not be fully compensated for the time they will need for the project.

There are multiple benefits to having co-directors instead of a single director. This allows workload sharing, which is especially valuable when one or the other is busy with their regular responsibilities. This also provides a built-in sounding board for developing ideas and thinking through decisions.

Include a project working group on each campus composed of personnel who can contribute directly to the project's goals and be champions for the project on their campus. Provide a stipend for faculty. Be clear about what each person will be asked to contribute and be realistic about the time required. Recognize that this type of assessment effort is complicated and time-consuming and can be especially demanding of the institutional research and educational assessment personnel on each campus. Be realistic about how much time they will be able to devote to the project.

Having outside consultants provides needed expertise, as well as an objective perspective on the project's goals, implementation and results. Again, it is important to be clear about their responsibilities.

PERSONNEL TURNOVER

It should be anticipated that during a multi-year project, turnover in participants (presidents, chief academic officers, faculty, and institutional research / educational assessment directors) will occur. Turnover in key personnel makes it more difficult to get the project's work done, and turnover in institutional leadership can complicate sustaining institutional interest and involvement. The effect of turnover can be mitigated by having clear goals, good records, project co-directors, and campus working groups.

COMMUNICATION

Provide clear, concise, and timely communication among project participants. Be clear about who is going to do what and by what date it is to be completed.

Communication between the project working group and the rest of campus is vital to sustaining involvement. This might be done through email, a newsletter, or announcements at chair or faculty meetings.

Bringing the participants together to talk about what has been learned, what to do next, how to resolve problems, etc. worked well for our project. While participants found the conference calls to be productive, it was the face-to-face meetings with all the working groups that were the most productive.

Produce a Project Book containing the survey instruments, a directory of data elements, and the associated analysis, and any conference proceedings. This will be useful for each campus and can serve as a baseline for further assessment. We produced a Project Book for each of our two annual meetings of project participants and after all the analysis was complete. This forced us to think through the data we had collected and how it would help answer our questions. Having these books also simplified writing the annual and final project reports for the Teagle Foundation.

When sharing data, keep in mind that the working groups will contain specialists who are experienced at sifting through tables of data and non-specialists who will have difficulty understanding the meaning of the data. Provide data and analyses in forms that all can understand.

HELPFUL USES OF TECHNOLOGY

Make use of technology to communicate and share. Tools we found particularly useful.

Doodle. Doodle.com provides a web based tool that was excellent for finding a time for conference calls. Each participant can log in and indicate availability for each of a range of time slots displayed as a simple matrix. The best time slot is then easy to spot.

FreeConferenceCall. FreeConferenceCall.com provides a logistical tool for conducting conference calls. It provides a common phone number where each participant can dial in to join a conference, even leave and come back if necessary. There is no service charge, but normal long distance phone charges apply. This is much better than using the PBS service that many campuses have that allows conference calls by manually dialing and linking in each participant from a single phone.

DropBox. Dropbox is a cloud-based directory service that allows multiple participants to share a common directory of files for reading and/or editing. Rights can be controlled and granted to as needed. The directory is web accessible so can be used from work, home, or when traveling. One problem is that there is no built in way to know if someone else is editing a file. We solved this problem by developing a system of moving a file to a “checked-out for editing” directory during editing. We used this for non-confidential documents only.

SurveyMonkey. SurveyMonkey is a well-known, inexpensive online survey tool. It worked well for us but had some quirks, and a new user should do a thorough trial run, including translating the responses into SPSS or other analysis package. In particular, “all of the above” type questions and responses from pull-down lists need special processing before analysis. An important feature we used, since we needed to link data from multiple surveys (student pre-capstone, student post-capstone, faculty mentor), was to assign each student and mentor a unique project ID that could be added to the URL of an email survey invitation and echoed back as part of the results file.

Excel and SPSS. We used Microsoft Excel for preparing survey data for import to SPSS. Some very useful features are the filtering capability (occasionally in conjunction with the subtotal functions, which recomputes totals, counts, or averages based on the filtered dataset), and the vlookup and hlookup functions. For instance the vlookup function was used to link together the

data from various surveys for a capstone using a capstone ID. SPSS was used for the analysis, and results exported to Excel for production of the final reports, where formatting and additional processing are easier. A general technique that was successfully used was to export the SPSS tables to an Excel spreadsheet, paste them into a separate tab in an Excel workbook and extract data from them using the vlookup function. Once set up, this allows rerunning the SPSS data after changes to the data or for different subsets of the data and simply replacing the SPSS output with a paste operation to produce the revised Excel tables. The vlookup requires identifying the row of data to be extracted with a unique identifier, which we found could be done fairly simply using three columns added to the left of the SPSS output that cascaded concatenations to identify the SPSS output table (MEANS, ANOVA, CORRELATIONS, etc.) and the SPSS variable name. Extracting SPSS columns to Excel and back to use Excel's data manipulation functions and other capabilities works very well, except for open-ended text survey responses from Survey Monkey, where invisible text characters may produce difficult-to-find errors. In general, be wary of including open-ended survey responses in SPSS files, at least if from Survey Monkey. In working with four schools, we found that working with different versions of Excel was a problem. We suggest establishing a single version to be used by all schools.

GENERAL BENEFITS

The project has had some tangible benefits already.

One campus has adapted the assessment instruments created for the project to create a common rubric for evaluating their capstones.

Working with three other similar schools has been valuable, not only for assessment generally and the capstone specifically, but for the general collaboration and informal time for sharing ideas, problems, and visions. As is always true, part of the benefit is simply the networking and sharing of ideas. It helped each campus better understand the workload issues related to capstone and how other institutions handled these complex issues.

Producing concrete action ideas to which each school will commit is valuable. These final steps each school will take are crucial to the success of this project.

Developing a better understanding of strengths and weakness of our programs compared to others. It is very useful to get out of the institutional bubble and to see things more holistically.

Identifying problems common to all institutions and potential solutions or the search of these solutions. We are all struggling to help relatively weaker students successfully complete their capstone as this increases faculty workload tremendously. Programs that have a large number of majors create faculty workload issues as well.

The overall findings of the study emerged through a considerable amount of noise and variation among schools, disciplines, and practices. However, the project demonstrates that hypotheses about pedagogies in higher education can be empirically studied.

References

- Bauer, K. W., & Bennett, J. S. (2003). Alumni Perceptions Used to Assess Undergraduate Research Experience. *The Journal of Higher Education*, 74(2), 210–230.
- Bonthius, Robert E., Davis, F. James, and Drushal, J. Garber (1957). *The Independent Study Program in the United States*. New York: Columbia University Press.
- Brownell, J. E., & Swaner, L. E. (2010). *Five High-Impact Practices: Research on Learning Outcomes, Completion, and Quality*. Washington, DC: Association of American Colleges and Universities.
- Kardash, C. M. (2000). Evaluation of an Undergraduate Research Experience: Perceptions of Undergraduate Interns and their Faculty Mentors. *Journal of Educational Psychology*, 92(1), 191–201.
- Kuh, G. (2008). *High-Impact Educational Practices: What They Are, Who Has Access to Them, and Why They Matter*, Association of American Colleges and Universities, Washington, D.C.
- Lopatto, D. (2010). *Science in Solution: The Impact of Undergraduate Research on Student Learning*. Washington, DC: Council on Undergraduate Research.
- Lopatto, D. (2010). Undergraduate Research as a High-Impact Student Experience. *Peer Review*, 12(2), 27–30.
- Lopatto, D. (2006). Undergraduate Research as a Catalyst for Liberal Learning. *Peer Review*, 8(1), 22–25.
- Lopatto, D. (2004). *What undergraduate research can tell us about research on learning* (Volume IV). What works, what matters, what lasts (pp. 1–4). PKAL. Retrieved from <http://www.pkal.org/documents/Vol4WhatUndergradResearchCanTellUs.cfm>
- National Survey of Student Engagement (2007). *Experiences That Matter: Enhancing Student Learning and Success*. Bloomington, IN: Indiana University Center for Postsecondary Research.
- National Survey of Student Engagement (2009). *Assessment for Improvement: Tracking Student Engagement over Time*. Bloomington, IN: Indiana University Center for Postsecondary Research.
- National Leadership Council for Liberal Education and America's Promise (2007). *College Learning for the New Global Century: A report from the National Leadership Council for Liberal Education & America's Promise*, Association of American Colleges and Universities, Washington, D.C.
- Seymour, E., Hunter, A.-B., Laursen, S. L., & DeAntoni, T. (2004). Establishing the benefits of research experiences for undergraduates in the sciences: First findings from a three-year study. *Science Education*, 88(4), 493 – 534.
- Taraban, R., & Logue, E. (2012). Academic Factors That Affect Undergraduate Research Experiences. *Journal of Educational Psychology*, 104(2).