

## **AC 2007-1465: USING INDEPENDENT-STUDY PROJECTS IN YOUR RESEARCH AND TEACHING PROGRAM**

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## Using Independent-Study Projects in Your Research, Teaching and Service Program

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### Abstract

Independent-study courses are offered by most institutions to allow a student to work one-on-one with a faculty member on a topic of interest to both. The rules vary widely with department and institution. They may be letter-graded, or graded pass/fail. Usually they are limited to three to six credits in a student's degree program. Sometimes the topics are constrained by the need to satisfy accreditation requirements. Many institutions require a syllabus, or a contract between the student and professor. Sometimes the contract is required to specify deliverables.

An independent study usually addresses a topic that is not covered in a regular course. Faculty can use them to build up their teaching and research program. For example, an independent study may be used to introduce a student to a particular research area in which (s)he may pursue a thesis (though in some cases, students are not allowed to earn both independent-study and thesis credits on the same topic). It may also be used to assist another student on a thesis project, as when an undergraduate gathers data that a graduate student can use in writing a thesis. Independent studies can also be used to enrich existing courses. A faculty member may want to introduce a new topic into a course, but lack time to produce the necessary lecture and homework materials. An independent-study student can scout the topic in advance and produce lecture notes and problems that can be used in teaching the course. This helps both the independent-study student, who learns about a new topic earlier than other students, and the rest of the class, which has access to better course materials than they would otherwise.

### 1. Introduction

As a new faculty member, you probably want to expand your research team and get extra help in preparing your courses. This paper will tell you how you can use independent-study courses to meet these needs, while simultaneously enriching the students' education by giving them the opportunity to work more closely with a faculty member than they do as a student in regularly scheduled courses.

Most of a student's college education involves taking regularly scheduled courses, either online or in a classroom environment with other students. But few institutions require *all* credits to be earned in this way; usually there is a provision for a student to earn some credits by on an individual project under the direction of a faculty member. Faculty usually receive no teaching credit for supervising projects like this, so why would they be interested? Because the project may be one that is of interest to them too. Assuming that the topic is job-related for the faculty, both students and faculty benefit from this approach: The student learns something that would not be learned in a regular course. Because the project is *independent*, the learning tends to be at a higher level of the Bloom taxonomy, e.g., application, analysis, or synthesis, rather than

knowledge or understanding. The faculty member gets help in meeting his research, teaching, or service obligations.

Focused independent studies have benefits that go far beyond the student's learning in the course of doing the project. Some of them will be mentioned later in the paper. For now, note that evaluation of students for fellowships and job opportunities is increasingly being done on the basis of portfolios. Independent-study projects, because they substitute for a course, are by nature larger than a project that could be given *during* a course, and therefore serve as better indicators of a student's unique accomplishments.

It should be mentioned that "independent study" is sometimes used in another sense: If a student needs a course for graduation, and that course is not offered in a particular semester, then a faculty member can offer the course to the student on an individual basis. This type of independent study is not covered in this paper.

## 2. Requirements for independent studies

Rules on independent studies vary widely among institutions and programs.<sup>1</sup> Generally speaking, a student is not allowed to substitute independent study for more than two courses. Many programs allow only one course (e.g., 3 semester hours or 4 quarter hours) of independent study. Others have per-semester limits (e.g., one course worth) and per-degree limits (e.g., two courses). The limit tends to be lower for master's students, reflecting the lower number of credits required for the degree. For undergraduates, some institutions are quite a bit more permissive; some allow more hours, but stipulate that they do not count toward the major. Others require them to be counted as free electives. Occasionally there is a process by which a student may *apply* to have the independent study counted toward meeting major requirements. There are rarely any limits on the topics that can be covered, and if there are, they tend to be general, such as a stipulation that the material covered must fall within the academic field of the department offering it. One restriction that the author has personally encountered is a rule that an independent-study course must have one of the "core" courses in the major as a prerequisite. There may be requirements as to how often student and instructor need to meet, e.g., once per week, or once every two weeks.

Some programs limit eligibility for independent studies, e.g., to students having a certain grade point average, most often 3.0, or to students in the major. Occasionally underclassmen (freshmen and sophomores) are prohibited from doing independent study. Universally, it seems, these courses require consent of the instructor. This is not surprising. More often than not, someone else besides the instructor needs to approve. This may be the department head, the program director, or the dean. Alternatively, the student's advisor may have to approve. Occasionally, it must be approved at more than one of these levels. The rationale is that the "course" is part of the curriculum, and thus should be approved by someone besides an individual faculty member. However, there are still a good number of programs where only the instructor's consent is needed.

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<sup>1</sup> Data comes from a survey posted to two listservs, SIGCSE-members@acm.org (Computer Science) and the Engineering Technology listserv (etd-l@listproc.tamu.edu) in January 2007. Responses were received from approximately three dozen programs.

### 3. Contracts and assessment

In most cases, independent studies are graded on the same scale as other courses (A, B, C, etc.). However, a substantial number of institutions grade them pass/fail, and sometimes the student or the instructor chooses whether they are to be pass/fail or letter-graded. The reason for requiring pass/fail grading is that, unlike a regular course, there is no one to compare the student with, and thus grading tends to be arbitrary. In fact, it is frequently observed that most independent-study projects receive grades of “A”, thus contributing to grade inflation. Pass/fail grading “fixes” that, since pass/fail grades aren’t factored into a student’s GPA.

Frequently, a contract is used to state what work is to be done, and what grade will be awarded if each of the deliverables is submitted by the date it is due. About two-thirds of programs appear to require this, but it is fairly common for instructors to contract with students even when it is not required. Hoskin and Welch<sup>2</sup> delineate the requirements for a successful contract. The student needs to understand the expectations—what the instructor will provide and what (s)he needs to develop. The instructor must determine that the student has the appropriate training and experience to carry out the project.

If a contract is not required, an outline, or at least a topic statement, frequently is, and often this must be approved by a departmental authority.

Assessment of independent studies is often hit or miss. In departments that make sporadic use of independent studies, usually there are no rules at all. One respondent to our survey justified that by saying that, since they are research, it is tough to predict what the outcome will be. Common assessment vehicles include weekly meetings, and interim or final reports. Only rarely is any kind of rubric required before the assessment is done.

Despite the lack of a formal assessment mechanism, faculty would be well advised to explain to the students what is expected of them, and what scale they will be evaluated on. An independent study can be one of the most rewarding parts of a student’s career, but if expectations are not communicated carefully, students tend to drift, being driven by other demands on their time, and accomplish little. Hoskin and Welch<sup>2</sup> give sample documents and timetables that can be used to track student progress.

### 4. Making effective use of independent studies

As a faculty member, you can wait for students to come to you and suggest projects you are interested in. Indeed, some independent-study course descriptions seem to assume that the student will usually initiate contact. However, because faculty have more research experience, it is more likely that *they* can suggest topics that will get the students excited about research. Consider your options for building an effective research program. You can start with research assistants (RAs), which are often funded as part of a faculty “startup package.” But how do you know who would make the best RA? You can go by performance in courses, but often grades do not correlate well with success in research. (This may come as a surprise, but it is true!) You can make a more informed decision if you actually supervise the candidate on a project; only then do important qualities like initiative and insight become apparent. Therefore, it makes sense to offer independent studies to a few more students than you have research funding for.

An independent study is more than just a “proving ground” for an aspiring RA. Project work is an important part of a student’s education. Even students who do not go into research will benefit by having some exposure to it. Moreover, expanding your base helps secure the longevity of your research projects. If your only assistance on a project is by a single RA, what happens when (s)he leaves or graduates? In research, as in so many other endeavors, there is safety in numbers.

## 5. Independent studies and research

How might an independent-study student assist with research? The possibilities are many. Let me list a few.

- Help set up a lab experiment, or a simulation environment. Lai and Sullivan<sup>3</sup> had independent-study students set up lab experiments in a polymer-processing laboratory, and provide feedback to improve the experimental procedures.
- Run a set of benchmarks on a simulator, and tabulate and analyze the results.
- Do a literature search in an area that you are interested in moving into; ideally, this could lead to a publishable survey paper.
- Write code for a program being used in research.

Other faculty have reported the following successes in integrating independent studies with their research programs:

“Yes - this project involves site work in the Virgin Islands National Park ([www.umaine.edu/set/met/VirginIslands.htm](http://www.umaine.edu/set/met/VirginIslands.htm)) during the 2-week spring break. They learned the required processes prior to the break, acquired the photographic data during the break, then produced 3-dimensional models from the data after the break. It was very successful.”—from a faculty member in Mechanical Engineering Technology at a flagship state university

“Yes. I have had several students whose independent study project was explicitly designed as an introduction to one of my research areas. Some of their projects were subsequently expanded into funded summer research projects, and several have produced publishable results.”—from a Computer Science faculty member at a regional state university

“Absolutely; every such study is focused on my research program. It has been extremely worthwhile doing so. While some students flop, it happens, about a third of my papers are authored with students who are, or were, undergrads. And some of those papers are in top places.”—a faculty member in Informatics at a Research I institution

The Civil Engineering department at the U.S. Military Academy offers every student an opportunity to undertake an independent-study project.<sup>4</sup> These are similar to capstone projects, but they need not include the four subdisciplines that ABET established as the minimum for a capstone project. Research projects are one of three categories (the others are competition and service projects), and faculty list projects that they are interested in undertaking. They are so popular with faculty that there are not enough students to go around.

The Civil and Environmental Engineering department at Lafayette College has used independent-study projects as a way to get undergraduates involved in research.<sup>5</sup> While many of these projects have no publishable product, over a six-year period, these students (in an 80-student department) made 17 conference presentations or publications, and wrote six journal articles. Presumably, many of these were joint publications with their instructor.

## 6. Independent studies and teaching

Independent studies are often equated with research. It's almost a secret that they can also be used very effectively to support teaching. In most technological fields, the state of the art is rapidly changing. If courses are to remain up to date, the examples and often the material itself needs change frequently. An independent-study student—particularly one who has taken your course—can help with this task by browsing the Web, or doing a literature search, for current examples or technical papers describing new developments. With a little help from you, the student can then revise a lecture to incorporate the new material. This student learns the new material ahead of the rest of the class (and at a higher level in the Bloom taxonomy), and subsequent classes benefit from the student's work.

Suppose that you have the opportunity to teach a research seminar in your field. Doing a good job means becoming familiar with current research in a fairly broad area. You are probably already an expert in a particular subfield, but you need to broaden your expertise. Rather than finding and reading all of the research papers yourself, assign an independent-study grad student to read them and discuss the general areas with you. You are much more likely to stay on top of the material and have the course set up in advance if you have someone working ahead.

When I have taught new languages in a programming-language course, I have engaged independent-study students to organize the lectures and write examples—even an occasional programming assignment. Continuous feedback from me is needed to keep the student on track, but the payoff is handsome: the material gets put together ahead of time, and I get a chance to reflect on it several times before I teach it.

Kiefer<sup>6</sup> describes an independent-study course in which six mechanical-engineering students developed a course in mechatronics. They spent ten weeks working projects and then six weeks doing a final project. They were responsible for finding background material (and they found many sources that the instructor would not have considered), and documenting the projects so later students could do them as part of the new course. All of the students had very positive evaluations of the course, even though they were not able to fully complete the final project by the end of the semester.

Gellin and Hotchkiss<sup>7</sup> used the work of an independent-study student to aid their effort to develop a CNC code generator used in a CAD/CAM course for engineering technology students. This will allow the students to use several CNC milling machines that are installed at their college.

Nagchaudhuri<sup>8</sup> had junior-level undergraduates dynamically model a crank slider mechanism. He intended to use their software in a required Dynamics course for Mechanical Engineering undergraduates.

Other faculty report independent-study projects to develop labs and lab experiments. An Engineering Technology instructor at a community college said, “Some projects have involved building or design and build of a piece of equipment to be used in other related courses.” The Mechanical Engineering Department at the University of Wisconsin-Milwaukee used several independent-study projects to set up a state-funded Air Compressor Experimentation Facility.<sup>9</sup> One of the projects set up a PC data-acquisition system to monitor air-compressor performance. Another performed thermal analysis of air-compressor operation using a thermal imaging camera.

One interesting way of bringing a benefit to teaching is to have a student test-drive a curriculum before adoption. One respondent reported having a student learn robotics from a packaged curriculum bought from a vendor. Based on that student’s experience, she decided not to order the curriculum for a subsequent class.

Civil Engineering students at the U.S. Military Academy, like their counterparts in other engineering departments, complete a capstone design project as a requirement for graduation. Students begin a project with a packet of information supplied by the instructor. Frequently this packet has been prepared by independent-study students in a previous semester.<sup>10</sup>

In general, the faculty who supervised independent studies related to their teaching seemed more satisfied in the outcome than those who used them to support their research.

## 7. Independent studies and service

Service is part of a faculty member’s mandate at land-grant institutions, but it is often a poor stepchild when it comes to time and effort. Faculty see fewer rewards from doing service, and it can often keep them away from activities that would help them get promoted. Thus, it is not surprising that faculty are most effective in a supervisory role, with the students doing the nuts-and-bolts work of getting a project going.

Here are some ways that independent studies have been used in service roles.

- Restoring equipment for a new museum.
- Developing a database for another program at the university.
- Developing robotics projects for a summer workshop for middle-school students.

Given the current popularity of service learning, it should be noted that many projects that are done in service-learning courses could also be done as independent studies. In fact, the U. S. Military Academy Civil Engineering department regularly has its students do independent-study projects to further some community goal. In one case,<sup>11</sup> the students aided in construction of a nature trail by excavating abutments, constructing footings, and emplacing a bridge across a creek. Another set of independent-study projects in that department is oriented toward designing earthquake-resistant housing for developing countries.<sup>12</sup> The University of Colorado Civil Engineering department has organized independent-study projects to solve a water or sanitation problem in poor communities in the developing world.<sup>13</sup>

Less altruistic but still important are projects that build ties to local industry. A computer engineer and construction engineer at the University of Cincinnati<sup>14</sup> teamed up to build a knowledge base that helped a construction company train its new professional hires. The company responded with a grant that established a scholarship program for the college.

## 8. Recruiting students: Practice and pitfalls

How are students to be selected for independent studies? I typically prefer to do a focused search. Sometimes the academic advisor knows of someone who would be a good match. I might also ask colleagues who teach related courses. Or, knowing that good results are dependent on getting good students, I e-mail the best students I have had in relevant classes in recent semesters. Sometimes I ask those students to spread the word to others who may be interested. In any case, I find that the best time for recruiting is the beginning of the registration period, when students are first formulating their class schedules.

There is a dark side to independent studies. A lot of them are not very successful, especially those related to research. Many students don't have the background, motivation—or direction—to do a good job. It is unfortunate that the assessment procedure for these courses in most departments is not better developed. Regardless of whether it is required, I would recommend the following:

1. An independent study should identify specific educational objectives, which are not covered by any other course that the student will take in his/her curriculum.
2. A tentative syllabus should be created, which identifies deliverables, specifies when they are to be completed, and tells when each of the educational objectives will be met.
3. Students should meet regularly with their instructor, and the syllabus should be referred to at each meeting.
4. The instructor should begin thinking about how to develop a detailed rubric for grading independent studies. Developing a good rubric requires experience, but the instructor should keep notes on each student's progress that can be re-read when developing a rubric.

Establishing this sort of framework helps both the student and the instructor. It helps the student because it insures that the independent study does not duplicate another course, and because it establishes a set of ground rules for deciding on a fair grade. It protects the instructor, because a written schedule encourages regular progress. The student can't claim that (s)he didn't know what was required.

Independent studies are a way to bring students and faculty together on a one-on-one basis. They help students to feel that they are more than just a number. For the student, they can be a great opportunity for résumé building. For the instructor, they offer a way to become more effective by delegating work to competent individuals.

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