EYP/® research

Assessment of the College of the Holy Cross Integrated Science Complex II

Analysis of Administrative Data

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Confidentiality Statement

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Executive Summary

To further assess the impact of the new Integrated Science Complex (ISC) at the College of the Holy Cross, EYP analyzed trend data from several administrative offices. With the ISC fully completed in January 2010, more time and data is needed to draw reliable inferences about its impact. In the meantime, this report offers some tentative conclusions while establishing a model for future analysis. Available data, most of which covers the period from 2000 to 2012, showed:

- A sharp increase occurred in applications for admission after 2005, apparently due to the college's making the submission of standardized test scores optional; however, there was no apparent change in number of applications following construction of the ISC.

- Since the ISC was completed, the college has hired a higher percentage of its first-choice job candidates in the four STEM departments, and a lower percentage of faculty members from these departments have voluntarily left the college. But these data is based on very small samples of searches and resignations.

- Enrollment data for the four STEM departments indicates systematic changes in one department since the ISC was completed. In chemistry, there have been marked increases in (1) number of majors, (2) enrollment in the introductory course Atoms and Molecules, and (3) enrollment in independent study courses, an indicator of student involvement in research.

- Although all three of these changes in chemistry are consistent with the impact of the new facilities, the possible effect of the ISC is confounded with the effects of changes in the curriculum and in the number of laboratory spaces open to students. Higher caps on enrollment may account for the increase in the number of students taking the introductory course, and reduced requirements for the major may have produced the increase in majors and, concomitantly, an increase in the number of students engaged in research.

- Over the past 15 years, there is no clear pattern over time in the amount of grant support in the STEM disciplines.

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Introduction

To assess the impact of its STEM buildings, EYP has begun a process of systematic research. We have developed an assessment plan that identifies several project goals and methods of assessment, and we have begun to gather data. At the College of the Holy Cross, where EYP designed a new Integrated Science Complex (ISC), we conducted post-occupancy surveys of students and faculty in spring 2011, one year after the complex was fully opened. Analyses of the surveys indicated that the new ISC has succeeded in accomplishing several important goals: Enhancing the perceived quality of the teaching environment, advancing faculty research, creating a welcoming place for students and faculty to meet, study, and work, and facilitating interaction among faculty and students. This report complements these findings by using data from institutional records to address several additional goals.

Our analysis of institutional data has two objectives: First, to expand the assessment of the ISC's impact on Holy Cross; second, to provide a template for future analyses of this kind of data, both at Holy Cross and elsewhere. Much of the data consists of statistical indicators maintained by various campus offices, such as Admissions, Grants, and the Dean and Academic Vice President. In general, the data covers an extended period—10 to 20 years. Given the recent completion of the complex, however, some of this data may not provide reliable measures of shifts or changes in trends after construction. Still, the evidence presented here provides an important baseline for analyzing the impact of the Integrated Science Complex; as the data is updated over the next several years, EYP and the College will be able to determine its effects more reliably.

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Analysis of Trend Data

Nearly all the data presented in this report consists of time series: Multiple observations or data points over time. For each series, we conduct an interrupted time series analysis. The "interruption" consists of the construction of the Integrated Science Complex. If the ISC has had the expected impact, the results should show a discontinuity in the series; that is, the data trend before construction should differ from the trend afterward. There are statistics for assessing the magnitude and statistical significance of shifts in time series; however, we will not apply these because we have too few data points following the construction of the ISC. Instead, we will apply "eyeball tests" based on plots of the data. As you will see, these tests are sufficient to identify apparent shifts in the series as of now; such shifts can be assessed more rigorously at a future date.

Two important caveats must be considered in interpreting results. Although most of the data show no shift in the time series, this is not unexpected. Many of the effects that EYP hopes to achieve are difficult to detect. Some effects will be small; others are subject to a large amount of error. For example, we cannot expect a new science complex to substantially increase admission applications. Besides the quality of academic buildings being only one of numerous factors that enter into students' decisions about where to go to college, the number of applications may vary randomly from year to year. For much of the data, therefore, the absence of a discernible difference should not be interpreted as evidence that the ISC has had no effect. The construction may not have had the hypothesized effect, or the effect simply may not be detectable with available data.

Second, when we do identify shifts in a time series, we must consider other factors that might explain the observed change. For example, in addition to a newly constructed science building, changes in admission standards, significant increases or decreases in tuition, and national trends such as the number of high school graduates who choose to attend college may affect applications. So, analysts must consider what else changed immediately before or during the period of building construction.

It is particularly important to consider the impact of chance factors. One reason that observing change from one year to the next may not be meaningful is that statistical indicators tend to go up and down over short periods because of random variation. In general, the smaller the number of observations, the greater the chance for random error; the longer the time period, the more likely that the data will reveal stable patterns of change. That is why it is crucial to obtain trend data for an extended period of time, both before and after construction. Most of the time series analyzed here contain 8-10 years of data prior to construction of the ISC; however, it has been only 3 years since the final phase of the ISC was completed. For the period after construction, one or two years is inadequate; three years is better but still not very reliable; and the longer the time period, the more reliable an observed change.

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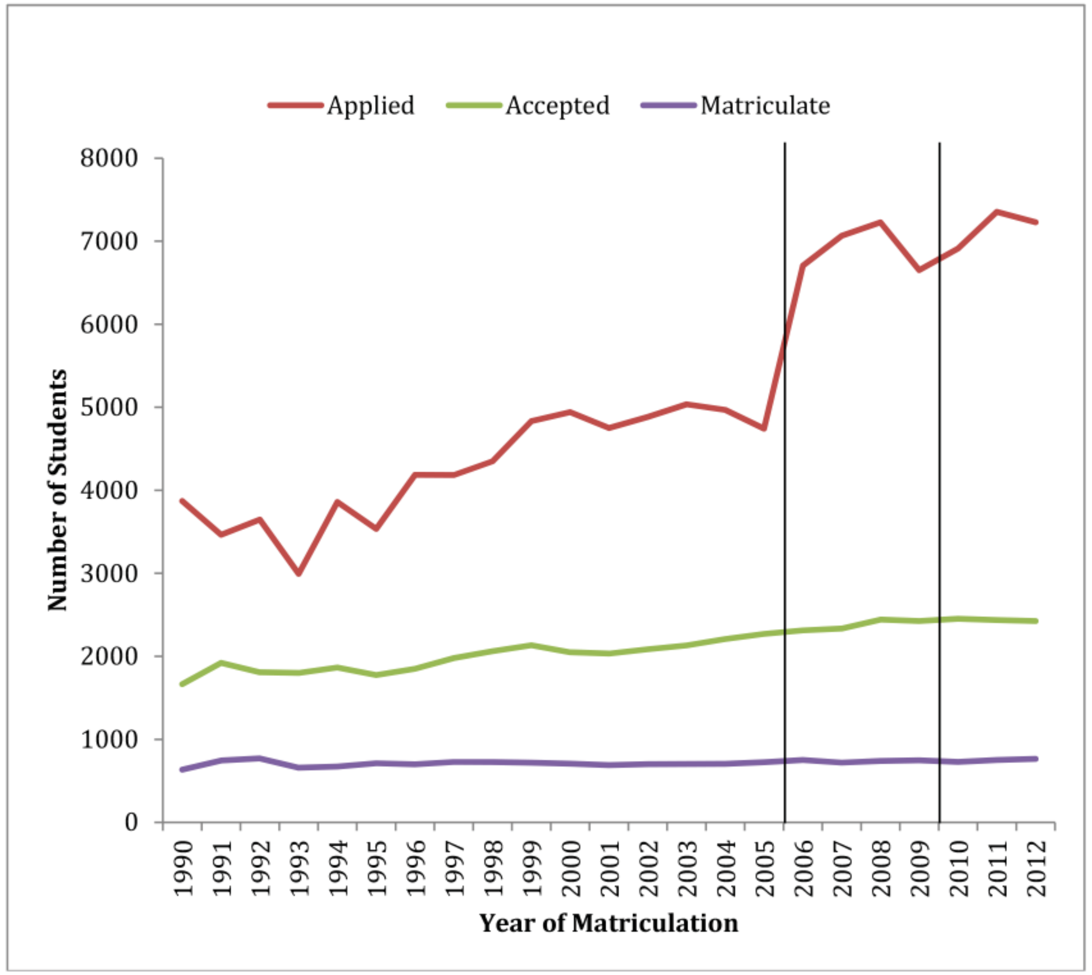
Figure 1. Holy Cross Admissions Data, 1990 - 2012



Results

We present each time series as a test of one of the goals outlined by EYP in its assessment plan. (See "Plan to Evaluate the Impact of Science Buildings on College and University Campuses.")

Goal 1. Make the institution more competitive in attracting students and faculty.

a. Has the number of applications for admission increased since the construction of the building?

To assess the impact of the ISC on admissions, we examined three statistics compiled annually by the Admissions Office: number of applications, number of students accepted, and number of students who matriculated. Figure 1 shows this data, beginning with the class that matriculated in fall 1990 and ending with the class that matriculated in fall 2012. Given that Holy Cross has neither the space nor inclination to increase the size of the student body, it is not surprising that the trend in number of matriculations shows virtually no change throughout this period. Over the past two decades, there appears to be a very gradual upward trend in the number of students accepted, which we will not attempt to explain. On the other hand, a clear discontinuity occurs in the number of students who apply for admission. Beginning with the class entering in fall 2006, there is a sharp increase, from 4,743 in fall 2005 to 6,706. Moreover, applications essentially remain at this level or slightly higher in each of the following six years.

What accounts for the shift? In this case, it is easy to explain. Prior to the fall 2006 entering class, Holy Cross required students to submit standardized test scores such as the Scholastic Aptitude Test (SAT); but beginning with this class, the submission of standardized test scores was optional. Dropping the requirement apparently encouraged applications from students with relatively low standardized test scores who were otherwise qualified. Supporting this interpretation, studies have shown similar spikes in applications for admission at other selective colleges that have made standardized test scores optional (see, for example, Epstein, 2009).1

Figure 1 contains vertical lines that represent two significant events: The first line, between 2005 and 2006, shows the point at which the college changed its policy on standardized test scores. Notice that the discontinuity in number of applications clearly appears at this juncture. The second line shows the date when the ISC was completed. It remains to be seen whether a second discontinuity will appear after this point in time.

b. Do applicants mention the science building as a factor in their decision to apply?

The Evaluation Plan suggested that the best way to answer this question was to add items to the Admitted Students Questionnaire (ASQ) that is sent each year to all students who are admitted to the college. Unfortunately, the recommended items have never been added. A less satisfactory option is to examine responses to a final open-ended question on the ASQ in which applicants are asked to write "any comments you would like to share . . . about our college's admission program." When we examined all 152 comments from applicants in the entering class of 2010, we found only one reference to the ISC, from a student who chose to enroll at Georgetown instead of Holy Cross. The student wrote that the "new science labs were a major draw and made me seriously consider Holy Cross." It is important to note, however, that most comments revolve around financial considerations; students hardly ever mention academic facilities.

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c. Is the college more successful in hiring its top candidates in the sciences?

To answer this question, we asked the Dean and Academic Vice President to provide information about hiring in all four STEM departments from 2000-2001 through 2011-2012. For each job search, we examined whether the person hired was the first choice or a later choice of the department. In the year when construction began, 2008-2009, one faculty member was hired in biology. Table 1 shows the percentage of job searches that resulted in hiring the top choice by department, before and after this transitional year. In two instances, a search failed when the department's first choice declined an offer; these cases were recorded as non-first choice job searches.

Table 1. Percentage of Job Searches in which First Choice was Hired, Before (2001-2008) and After (2010-2012) Construction of Integrated Science Complex.

	Biology	Chemistry	Math C/S	Physics	Total
Before construction	55.6% (9)*	50% (8)	75% (4)†	100% (1)†	59.1% (22)
After construction	100% (3)	75% (4)*	100% (1)	0% (1)	77.8% (9)

*Includes one failed search.
†Information not available on two searches.

Complete information was available for 31 job searches: 22 before construction and 9 afterward. As the table shows, the college succeeded in hiring 59.1 percent of its first-choice candidates prior to construction of the ISC and 77.8 percent afterward. Furthermore, the percentage of first-choice hires increased after construction in three of the four departments, the only exception being physics, where only one person has been hired. The data is thus consistent with the goal of making the college more competitive in faculty hiring. However, with so few job searches since construction, we do not have enough data to conclude that this increased success rate is a consequence of the Integrated Science Complex.

d. Has the building increased the likelihood of retaining faculty members?

To measure retention, we examined the number of STEM faculty who left the college voluntarily between 2001 and 2012. Prior to construction of the ISC, there were 11 resignations: 4 in biology, 5 in chemistry, and 2 in mathematics and computer science. Since construction, there have been 2 resignations, both in math and computer science. There are, of course, many reasons why faculty members leave the college, only one of which may be the quality of teaching and research facilities. Although we requested information on faculty members' reasons for leaving

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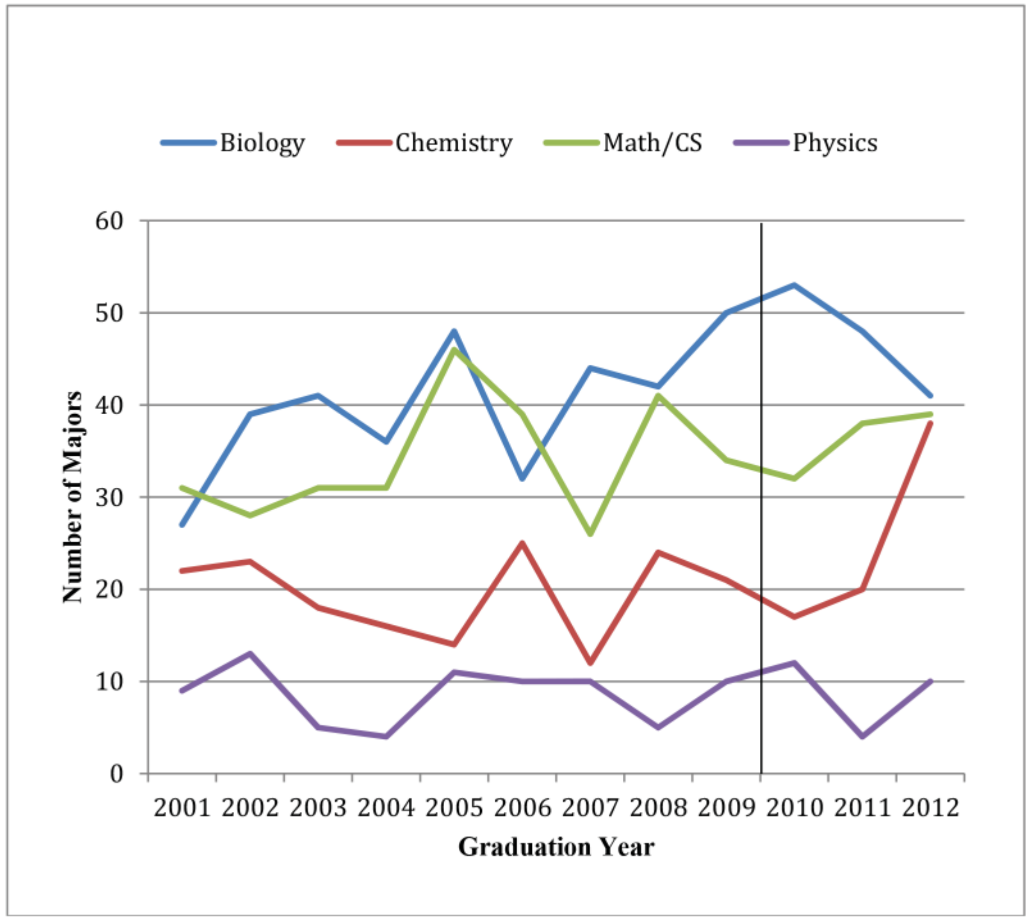
Figure 2. Number of Majors Per Graduating Class, 2001 - 2012



the college, the Academic Vice President understandably denied our request because he deemed this information as too sensitive. Nonetheless, the pattern of change is encouraging; it suggests that, especially in chemistry, that the ISC and its new laboratory facilities may be having a positive effect on retention. Like the data on job searches, however, it is too soon to draw this conclusion with any certainty.

Goal 2. Enhance students' interest in science.

a. Has the number of students majoring in science increased?

To answer this question we tracked the number of majors in each graduating class from 2001 to 2012. We used graduating class rather than all four classes because at Holy Cross the vast majority of students matriculate without a major, and students are not required to declare a major until the end of their second year. If the ISC has an impact on students' choice of major, we would expect it to begin with the class that was in its second year when the building was completed, 2009-2010. And since that class did not graduate until 2012, we would expect the data to show a lagged effect, such that an increase in majors should begin to appear two years after the construction of the ISC.

Figure 2 shows the number of majors for each of the four STEM departments. Two years after the ISC was completed, the most marked change occurs in chemistry. Between 2001 and 2011, chemistry averaged 19.3 majors per graduating class, with a high of 25. From 2011 to 2012 the number of chemistry majors almost doubled, from 20 to 38. One year is insufficient to draw any conclusions about the impact of the ISC; however, additional data is consistent with this interpretation. For according to the Registrar, the number of chemistry majors remains relatively high: 32 in the class of 2013 and 36 in the class of 2014.
What else, besides the ISC, could account for this change? A remote possibility is that the increase in chemistry majors reflects a national trend. The National Center for Educational Statistics, which compiles data on bachelor's degrees conferred at all U.S. degree-granting institutions, has not released data on the number of degrees in chemistry beyond the 2010-2011 academic year. Available data suggests, however, that national trends are highly unlikely to account for the increase in majors at Holy Cross. From 2001 to 2011, the percentage of all U.S. bachelor's degrees that were conferred in chemistry averaged .71 percent per year; and between 2006 and 2011, this percentage was relatively stable, varying between .71 and .74 percent.2 By comparison, during this period, the number of degrees conferred in chemistry at Holy Cross ranged from 12 to 25.

A second possibility is that changes in major requirements have encouraged more students to enroll in chemistry. For example, reducing the number of required courses or eliminating a particularly demanding course might make the major more attractive. This would be especially true for students in the pre-medical program, who have few elective courses. The chemistry department did make a significant change in its requirements. Prior to the class of 2011, chemistry majors were required to complete 10 courses and 8 labs. Beginning with the class of 2011, majors had to take one fewer course and two fewer labs. Given that the new requirements were announced when the class of 2011 was in its second year, it seems likely that the full effect of this change would not occur until 2012. This is, of course, the same year in which we expected to see the impact of the ISC. Thus, we cannot know whether the increase in majors was due to the new building or to the change in major requirements.

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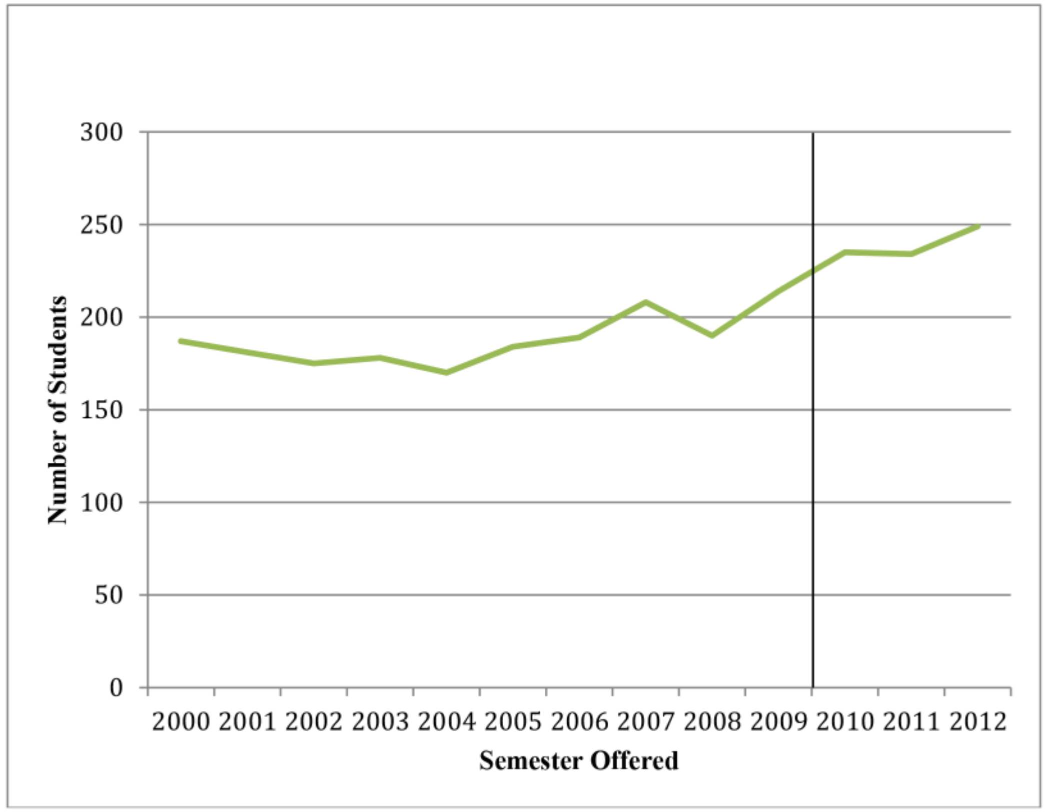
Figure 3. Enrollment in Atoms and Molecules,M Fall 2000 - Fall 2012



b. Have enrollments in science courses increased?

By making science more visible through glass-walled laboratories, the new Integrated Science Complex may increase students' interest in science. And, if their interest is piqued, students might be more inclined to enroll in STEM courses. One way to gauge whether enrollments have increased would be to track total enrollment in the natural sciences; another method would be to examine enrollment in first-year science courses or in courses designed specifically for non-science majors. These statistics will only be indicative of student interest, however, if enrollments are primarily a function of student demand. If enrollment is capped for all courses, and if the number of courses offered remains the same, this will establish a ceiling on enrollment that will not reflect demand. Unfortunately, both of these conditions generally apply to Holy Cross; moreover, nearly all first-year courses in the STEM disciplines fill to capacity.3

Consider the first course students take in chemistry, Atoms and Molecules, which is required for chemistry majors as well as students in the pre-medical program. Figure 3 shows the number of students enrolled in this course from fall 2000 to fall 2012. Between fall 2000 and fall 2009, enrollment averaged 185 students. Overall, and in 6 of the 9 semesters, enrollment exceeded the class limit. This was done to accommodate, so far as laboratory space would allow, students who needed or wanted to take the course. We cannot know, now, how many more students, if any, would have taken the course if more laboratory sections had been offered. Figure 3 shows a steady increase in enrollment in Atoms and Molecules since Smith Laboratories opened, from an average of 196 students in the three years before the new labs opened to an average of 233 students in the four years afterward.

Like the change in major requirements, the construction of the new labs is confounded with another factor. One year after Smith Labs opened, in fall 2010, the Chemistry Department reduced the length of the lab for Atoms and Molecules from 4 hours to 2½ hours, resulting in an increase in the number of lab sections and in course capacity. So, it is impossible to know whether the increase in enrollment is due to the building or to the change in course limits.

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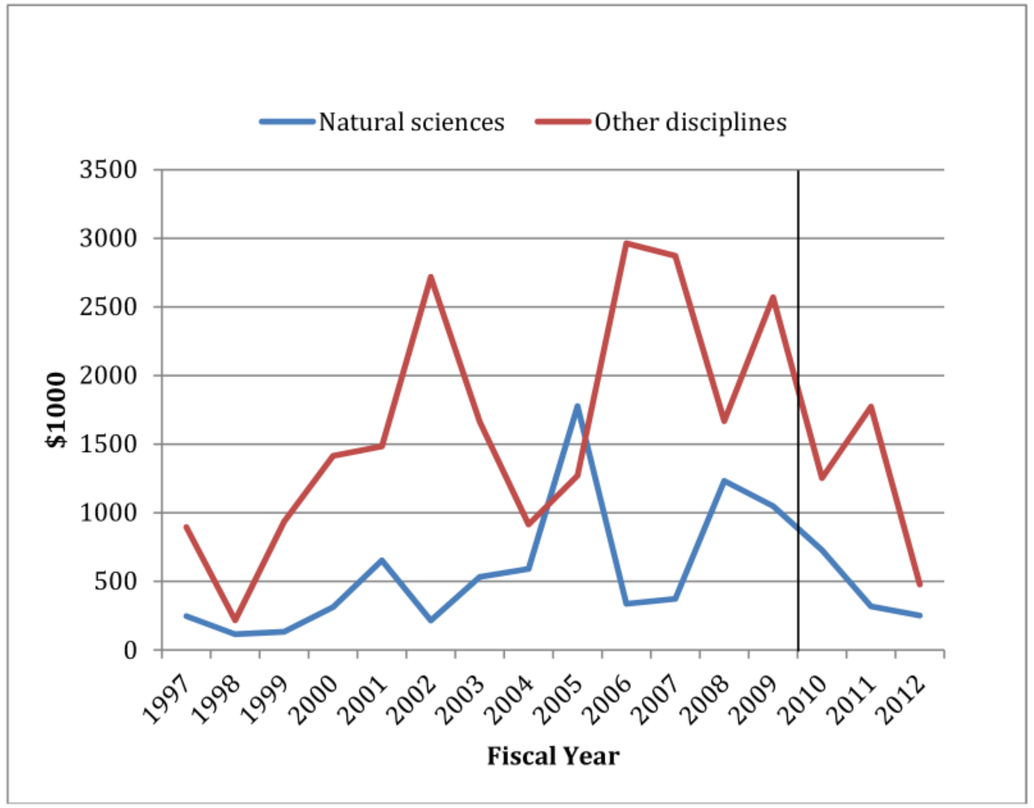
Figure 4. Grant Awards in Thousands by Year, 1997 - 2012



Goal 3. Advance faculty and student research.

a. Has the number and amount of research grants in the sciences increased?

The quality of academic facilities is critical for faculty research. Facilities must be adequate to conduct research, and better facilities make it easier to carry out research. Faculty members routinely apply for grants to support their research. One possible effect of the new laboratory facilities is an increase in grant support.

Figure 4 shows the amount of grant money awarded in the natural sciences and in other disciplines from 1997 to 2012. Throughout this period, clear trends are difficult to discern. If anything, there appears to be a cyclical pattern in which increases in funding tend to be followed by decreases. This pattern is consistent with the practices of both funding agencies and research scientists. Many agencies issue periodic invitations to institutions to apply for awards; however, once an invited proposal is awarded, some agencies do not allow an institution to apply again for a few years. More importantly, funding generally covers 2-3 years, so that scientists apply for grants periodically as needed. To detect trends and to determine the impact of the ISC on grant support, therefore, we must examine funding over a much longer period of time.

b. Has the number of students doing research in the sciences increased?

Across the natural sciences at Holy Cross, students who are engaged in research enroll in independent study (IS) courses.4 In most of these courses, students perform the role of a research assistant, offering critical support for faculty research. Norms vary by department regarding the number of IS courses offered and the number of students who enroll, but there has been no apparent change in these norms over the past several years. So, enrollment in IS courses should be a good indicator of the impact of the ISC on student involvement in research.

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Figure 5. Number of Students Enrolled in Independent Study Courses, Fall 2002 - Spring 2012

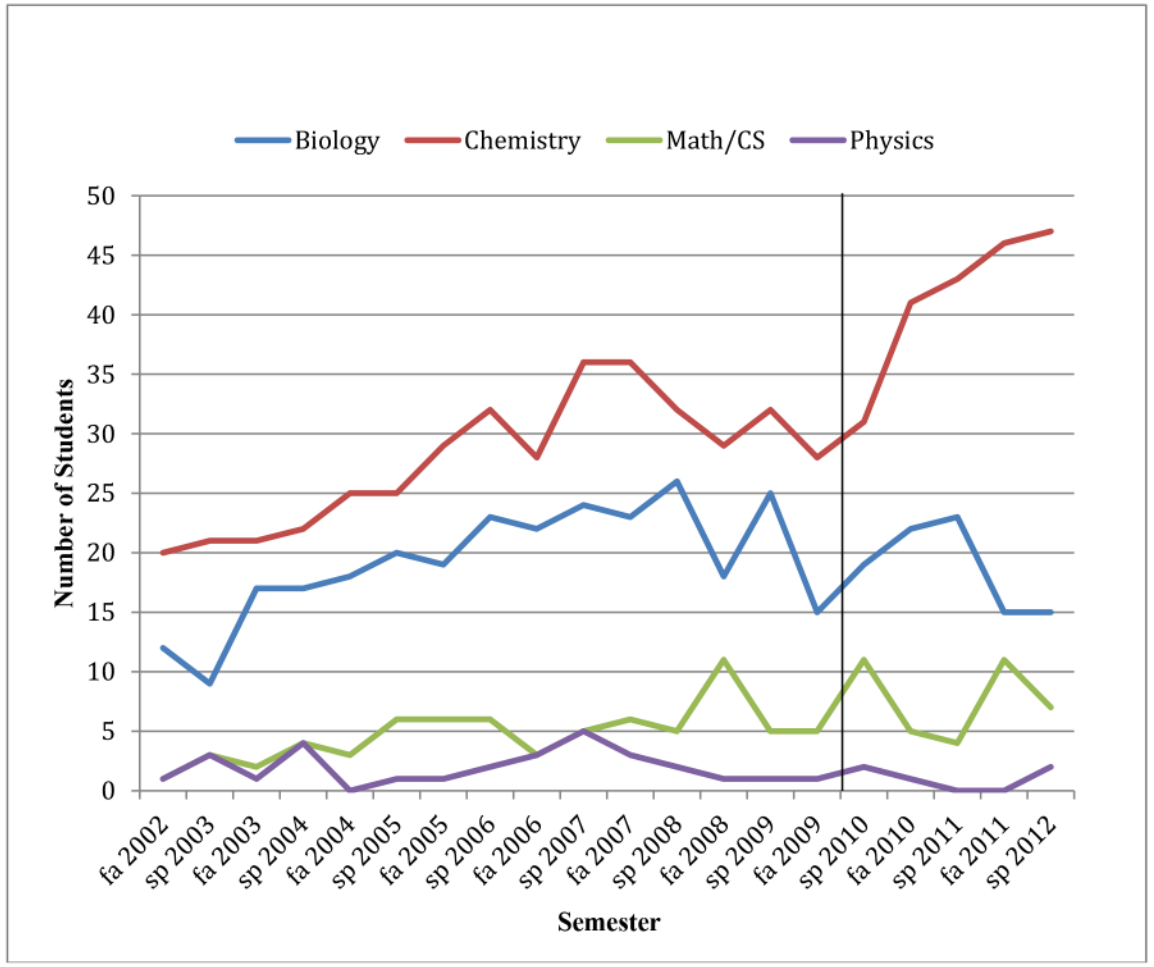

Figure 5 shows the number of students enrolled in IS courses by department from fall 2002 to spring 2012. Once again, the vertical line in the figure shows the date when the ISC was completed. Mathematicians generally do not do laboratory research, and research facilities in biology were unchanged by the construction of the ISC. So, as we might expect, there is no apparent shift in the trend for either of these departments. We also find very little change in the generally low enrollment in IS courses in physics. However, there is a sharp and steady increase in the number of students enrolled in IS courses in chemistry after completion of the Integrated Science Complex.

Can we attribute the shift in chemistry to the impact of the ISC? And, if so, why did the ISC not have a similar impact on physics? The number of students enrolled in IS courses each semester depends on the number of tenured and tenure-track (T/NT) faculty and the number of students who express an interest in doing research. The number of T/NT faculty in chemistry actually decreased by one in the first full year after the ISC was completed, 2010-2011; therefore, this could not account for the shift shown in Figure 5. The ISC may have increased students' interest in research; however, this also may be due to the increase in majors.

There are several reasons why the ISC would not have had a similar impact on physics. Whereas every member of the chemistry department is a laboratory scientist, three of the eight members of the physics department are theorists, and one member uses a laboratory at another institution. In addition, the new construction resulted in more dramatic changes in the laboratory facilities in chemistry than in physics. Chemistry labs in the old building were more rundown, the available space was more limited, and the facilities were less adequate to meet research needs. The old chemistry laboratories also were in the basement, hidden from view, whereas now they are readily visible through glass walls. Added space in the new labs has enabled chemistry to accommodate more research students; and some chemists believe that the visibility of the labs has increased student interest in doing research.

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Conclusions

Using trend data from various administrative offices, we examined the extent to which construction of the Integrated Science Complex at the College of the Holy Cross has met three broad goals. Given the limited time since the ISC opened, we do not have enough data to draw firm conclusions about its impact. But the data does suggest some positive changes that warrant further examination after more time has elapsed.

Although there is no evidence that the new science facilities have affected student applications for admission, information on faculty hiring and retention shows that the college has become more competitive in attracting and retaining faculty. This conclusion is based, however, on a very small sample of job searches and voluntary resignations and therefore should be tracked for several more years.

Among the four STEM departments, chemistry appears to have experienced the greatest improvement in the quality of its classrooms and laboratories; therefore, if the new facilities stimulate students' interest, this is most likely to occur in chemistry. Several indicators are consistent with this interpretation: an increase in number of (1) chemistry majors, (2) students enrolled in the introductory course Atoms and Molecules, and (3) students enrolled in independent study courses, a good indicator of student involvement in research. Strong alternative explanations, however, cast doubt on the impact of the ISC. For concurrent with the completion of the new complex, the chemistry department made changes in major requirements that were likely to increase the number of majors and the number of students engaged in research, and the department also increased the course limits for students enrolling in Atoms and Molecules.

Finally, data on grant funding in the STEM disciplines shows that the amount of grant support varies markedly from year to year, and so this data must be examined over a long period of time to discern clear patterns.

Footnotes

1.
See, for example, Jonathan P. Epstein, "Behind the SAT-Optional Movement: Context and Controversy," Journal of College Admission, Summer 2009, pp. 9-19.

2.
See Institute of Education Sciences, National Center for Education Statistics, Digest of Education Statistics, 2012 Tables and Figures, Table 283 (Degrees conferred by degree-granting institutions, by level of degree and sex of student: Selected years, 1869-70 through 2021-22) and Table 329 (Degrees in chemistry, geology and earth science, and physics conferred by degree-granting institutions, by level of degree: 1970-71 through 2010-11).

3.
Across the college course offerings are designed to meet common area requirements and to cover disciplinary curricula, including major requirements. All students are required to take courses in various areas of the curriculum, including two courses in the STEM disciplines, at least one of which must be in natural science. In addition, pre-medical students must take courses in biology, chemistry, and physics; biology majors must take courses in chemistry and physics; and chemistry majors must take courses in physics. Every STEM department therefore must schedule courses to meet these requirements.

4.
"Independent study" is a generic label that describes several courses in which students enroll individually with the permission of the instructor. For example, the Physics Department offers Independent Study (PHYS 461) and Undergraduate Research (PHYS 471 and 472); Chemistry offers Introduction to Research (CHEM 389), Independent Research (CHEM 390), General Research 1, 2, 3, and 4 (CHEM 405-407), and Advanced Research (CHEM 410).

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