EYP/ research

Assessment of the Impact of the Taylor Science Center
Hamilton College

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/ Table of Contents

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/ Executive Summary

To assess the impact of the Taylor Science Center at Hamilton College, EYP analyzed trend data from several administrative offices compiled by Assistant Dean Gordon Hewitt.

Available data, most of which cover the period from 2000 to 2014, showed:

- The construction of the TSC appears to have made Hamilton more competitive in attracting students, as applications for admission increased by almost 500 after the opening of the Science Center.
- Supporting this interpretation, students completing the Admitted Students Questionnaire rated Hamilton as lower than comparison schools on “quality of academic facilities” prior to construction but as higher afterward.
- Although the quality of students as measured by standardized test scores has risen steadily since 2000, we cannot say whether or how much the Science Center has contributed to this increase.
- Construction of the TSC appears to have stimulated student interest in science, with enrollments in 100-level science and math courses increasing by an average of more than 150 students, and the number of graduates majoring in the sciences and math increasing by an average of nearly 42 students since construction.
- Amount of extramural grant funding in the sciences, a crude indicator of faculty research, varied markedly from year to year, both prior to and following construction of the TSC.
- The number of students participating in the summer research program in the sciences increased markedly in the summer after the TSC was completed and has remained at this higher level since then.

/ Introduction

To assess the impact of its STEM buildings, EYP has instituted a process of systematic research. We have developed an assessment plan that identifies several project goals and methods of assessment, and we have gathered data at several institutions.

At Hamilton College, EYP designed the Taylor Science Center (TSC), the largest construction project in the history of the college. Completed in September 2005, construction of the TSC involved the complete renovation of one building, demolition of a second building, and the additions of a multi-story wing and a two-story atrium connected to the renovated existing building. Initially, the new Center housed offices and laboratories in six departments: archaeology, biology, chemistry, geology, physics, and psychology. (The Center also had two computer science classrooms and in 2011 added offices of the Computer Science Department.) The construction increased the space available to the six departments, including shared space, by over 50 percent, from 68,450 to 106,442 square feet. The exterior design of the TSC preserved the façade of the original 1925 Science Building while adding modern elements, including large windows and a sky roof. The interior design substantially increases the size, quality, and structure of classrooms and laboratories; features glass-walled laboratories that make science visible from the hallways; and provides many commons areas for students and faculty to meet.

This report analyzes data from institutional records to address several goals. Much of the data consists of statistical indicators maintained by various campus offices, including Admissions, the Dean of Faculty's office, and the Registrar's Office.

/ Analysis of Trend Data

Nearly all the data presented in this report consist of time series: multiple observations or data points over time. For each series, we conduct an interrupted time series analysis. The "interruption" is the completion of the Taylor Science Center (TSC). If the TSC 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 when we have too few data points for a meaningful analysis.

Two important caveats must be considered in interpreting results. Although some of the time series show no disruption following construction of the TSC, 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 necessarily 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 apply 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 TSC 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, an increase in admissions applications may occur because of 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. So, analysts must consider what else changed immediately before and after 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 analyze trend data for an extended period of time, both before and after construction. Most of the time series analyzed here contain 15 to 20 data points, with 4-10 years of data prior to and following construction of the TSC. Although the number of data points needed for a reliable statistical analysis is somewhat arbitrary, some analysts recommend around 50.

/ 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.

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

To assess the impact of the TSC 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 these data, beginning with the class that matriculated in fall 1988 and ending with the class that matriculated in fall 2014. Given that Hamilton has neither the space nor inclination to increase the size of the student body, acceptances are carefully gauged to produce a student body of around 1,850. Therefore, it is not surprising that the trend in number of matriculations shows virtually no change throughout this period.

Figure 1: Hamilton Admissions Data; 1988-2014

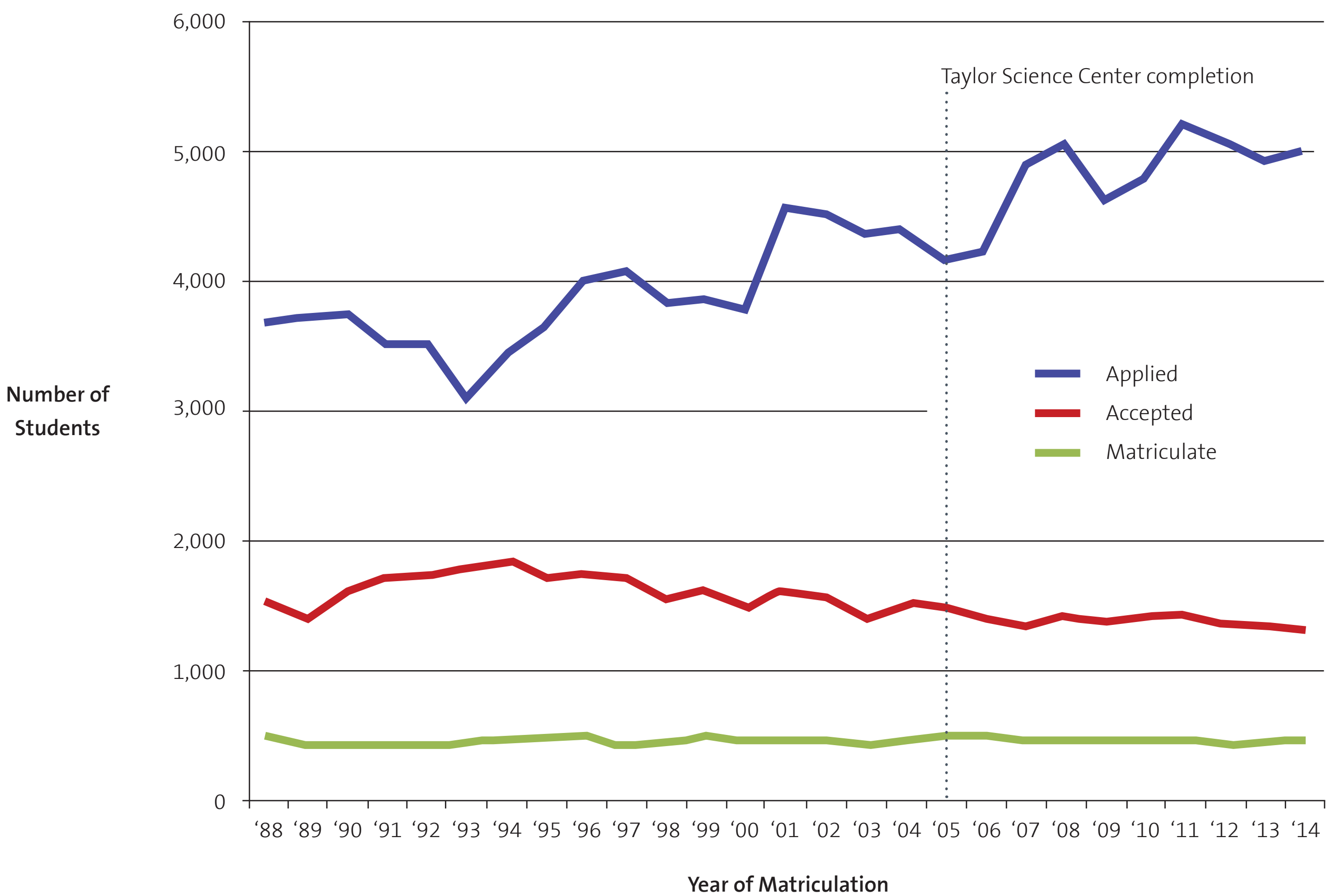


Figure 1 further shows a gradual downward trend over the past two decades in the number of students accepted, from a high of 1,879 in 1994 to a low of 1,336 in 2014. As a result of this decrease and the constant number of matriculations, Hamilton's acceptance rate has declined from over 50 percent in the mid-1990s to 26 percent in 2014. Concomitantly, the yield has increased from 25 percent to its current level of 35 percent. Both the trends in acceptance rate and yield are likely to be the product of many factors, including the College's considerable investment in new construction and building renovations over the past ten years. However, we cannot say how much the TSC accounts for these trends.

On the other hand, the number of applications increased substantially, from a low of 3,140 in 1993 to more than 5,000 in four of the last seven years. A contributing factor may be a nationwide increase in college applications that occurred in the first decade of the new millennium.[1] However, there appear to be two discontinuities in the number of students who apply for admission. The first occurs around the year 2000. Before then, the average number of applications was 3,723, whereas between 2001 and 2006, applications averaged 4,412. The second discontinuity occurs in 2007, when the number of applications jumped to 4,962; since then, applications have averaged just over 5,000.[2]

What accounts for these shifts? The sharp increase from 2000 to 2001 could be the result of Hamilton's move to an "open curriculum," which eliminated distribution requirements beginning with the class that entered in 2001. The second shift could be a lagged effect of the construction of the Science Center. Other events occurring at Hamilton around this time include the construction of the Charlean and Wayland Blood Fitness and Dance Center in 2006 and extensive media attention given to Hamilton's invitations to two controversial figures—Susan Rosenberg to teach as an artist-in-residence and Ward Churchill to speak—in 2004-05. Although these and other factors may have contributed to the increase in admissions after 2006, the timing, as well as other evidence, presented below suggest that the construction of the TSC was a major influence.

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

Hamilton is one of hundreds of colleges that use the Admitted Students Questionnaire (ASQ), a market research tool created by the College Board. The ASQ asks admitted students what they think of the institution in terms of majors and course curricula, campus facilities, quality of social life, and other dimensions. The College Board prepares the questionnaires; the institution sends them to admitted students and then sends the completed questionnaires to the College Board, which analyzes the results and provides detailed reports.

Every other year from 2004 through 2014, and in selected years prior to 2004, Hamilton sent the ASQ to all admitted students. Two standard ASQ questions may be used to assess the importance and general impact of academic facilities such as the Taylor Science Center. Question 5 asks students to rate the importance (very important, somewhat important, not important) of the college's "quality of academic facilities (library, laboratories, etc)" in making their college choice; Question 25 then asks students to rate "quality of academic facilities" at Hamilton College and two other colleges to which they were admitted.

In every survey of students admitted to Hamilton that we examined, 50 percent or more of the respondents rated the quality of academic facilities as "very important." Prior to 2006, the mean rating of Hamilton on this characteristic was always lower than the comparison schools; however, beginning in 2006 and in every subsequent survey, the mean rating of Hamilton was higher than comparison schools. Table 1 shows the results from the College Board's detailed report for the 2004 and 2006 ASQ. This finding is consistent with the increase in applications for admissions beginning in 2006.

Table 1. Characteristics Rated as Very Important* in the 2004 and 2006 ASQ Surveys and Comparison of Hamilton with Other Schools.

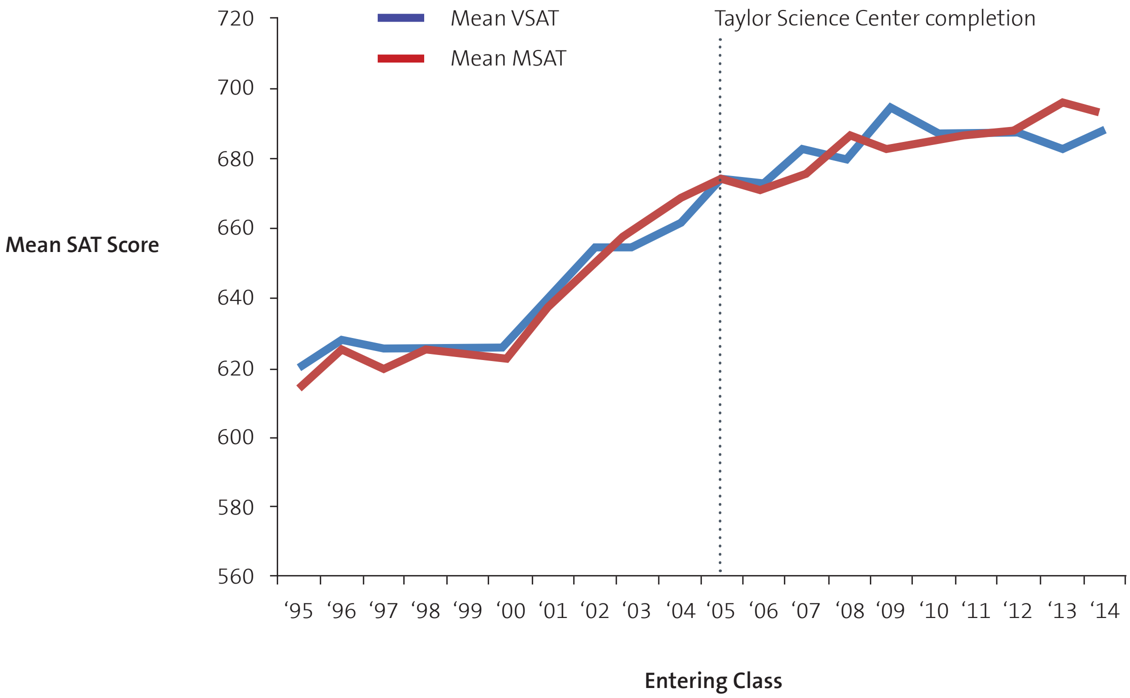
Year	Very Important/Hamilton Rated Higher	Very Important/Hamilton Rated Lower
2004	Personal attention	Quality of social life
	Attractiveness of campus	Availability of majors
	Extra-curricular opportunities	Academic reputation
		Quality of academic facilities
2006	Personal attention	Quality of social life
	Attractiveness of campus	Availability of majors
	Extra-curricular opportunities	
	Quality of academic facilities	
	Academic reputation	
	Study abroad opportunities	

*Rated as "very important" by at least 50 percent of respondents.

c. Has the quality of applicants for admission increased since the construction of the building?

Another possible outcome of the new science building is an increase in the quality of applicants for admission. The most readily available indicator of applicant quality is SAT scores. When we tracked mean Verbal and Math SAT scores for the entering classes from 1995 to 2014 (see Figure 2), we found a steady increase beginning with the class of 2001. Thus, there is no evidence that construction of the TSC stimulated an increase in applicant quality in terms of standardized test scores, although it is certainly possible that the new building has contributed to the steady increase in scores in the new millennium.

Figure 2: Mean Verbal and Math SAT Score by Entering Class; 1995-2014



Goal 2. Enhance students' interest in science.

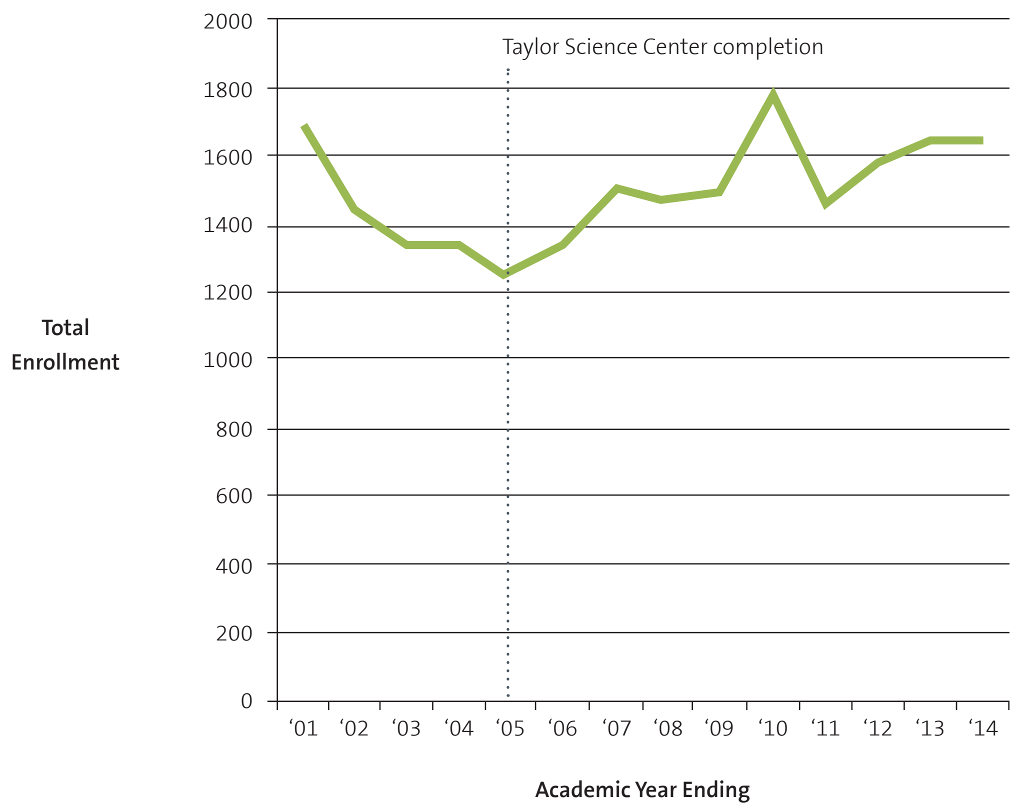
a. Have enrollments in science courses increased?

By making science more visible through glass-walled laboratories, the Taylor Science Center may increase students' interest in science. And, if their interest is piqued, students might be more inclined to enroll in science courses. One way to gauge whether enrollments have increased is to track total enrollment in first-year science courses. This will be indicative of student interest provided that enrollments are primarily a function of student demand. If enrollment is capped for all courses, and all courses tend to fill to capacity, then enrollment will merely be a function of the number of courses offered. At Hamilton, however, enrollments tend to be well below demand; for example, 100-level science and math courses offered between 2001 and 2014 averaged 66 percent of capacity.

Figure 3 shows enrollments in 100-level science and math courses between 2000 and 2014. Data for the first two years, 2000-01 and 2001-02, contain two "outliers" that inflate the number of students enrolled in science courses: (1) 370 students enrolled in 100-level computer science courses in 2000-01, including 202 in a single course in fall

2000, as compared with an average annual enrollment of 160 for the other 13 years; and (2) 270 students enrolled in 100-level physics courses in 2001-02, as compared with an average of 165 for the remaining years. If these outliers are converted to average values, enrollment in 100-level science courses is just over 1400 in 2000-01 and between 1300 and 1400 from 2001-02 to 2005-06. Then, beginning in 2006-07, enrollment exceeds 1500. In other words, there is a marked increase in enrollment one year after the opening of the TSC.

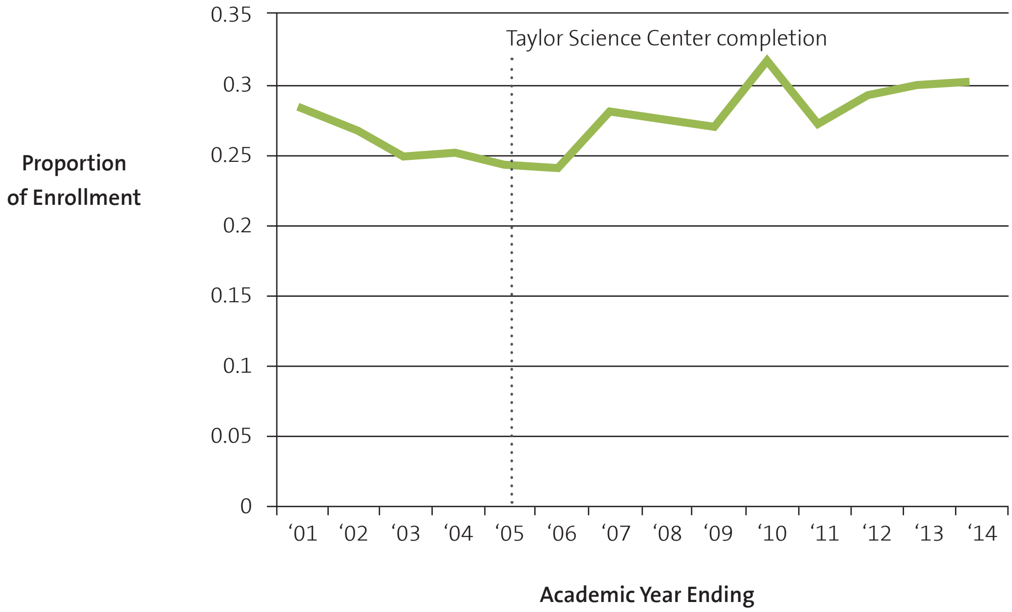
Figure 3: Enrollment in 100-Level Science Courses* by Academic Year; 2000-2001 to 2013-2014



**Includes courses in Biology, Chemistry, Computer Science, Environmental Studies, Geology or Geological Science, Mathematics, Neuroscience, Physics, and Psychology.*

When the outliers are taken into account and number of students enrolled in 100-level sciences courses is converted to the proportion of enrollment in all 100-level courses, as shown in Figure 4, the proportion of students taking science courses increases from around .25 prior to construction to .28 in 2006-07 to .30 in the last two years.

Figure 4: Proportion of Enrollment in 100 Level Courses in Science by Academic Year; 2000-2001 to 2013-2014



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

When students matriculate without a declared major, which is true of the vast majority of students at Hamilton, they often choose a major based on their experience in introductory courses. Therefore, if the TSC encourages enrollment in introductory science courses, we also should see an increase in the number of students majoring in science. To check this expectation, we tracked the number of majors in each graduating class from 1999 to 2014. We used the graduating class rather than all four classes, because at Hamilton, students are not required to declare a major until their fourth semester. If the TSC 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, fall 2005. And since that class did not graduate until 2008, we would expect the data to show a lagged effect, with an increase in majors occurring two years after the academic year in which the TSC was completed.

Figure 5 shows the number of majors for each of the four subject areas at Hamilton. The "sciences" includes all but one department (archeology) housed in the TSC, plus mathematics. Only the sciences and math show a clear increase in majors since the construction of the TSC, although this increase begins in 2009, a year later than expected. Because the number of majors varies with the size of the graduating class, we can get a more accurate estimate of the impact of the building by examining the relative proportion of majors, as shown in Figure 6. As this figures shows, the proportion of all majors that are in the sciences increases from .30 in 2006 to .33 in 2007 to .34 in 2008, and climbs to .40 by 2012. In other words, the increase in proportion of majors in the sciences begins to occur one year after the completion of the TSC.

Figure 5: Number of Majors by Subject Area by Graduation Class; 1999-2014

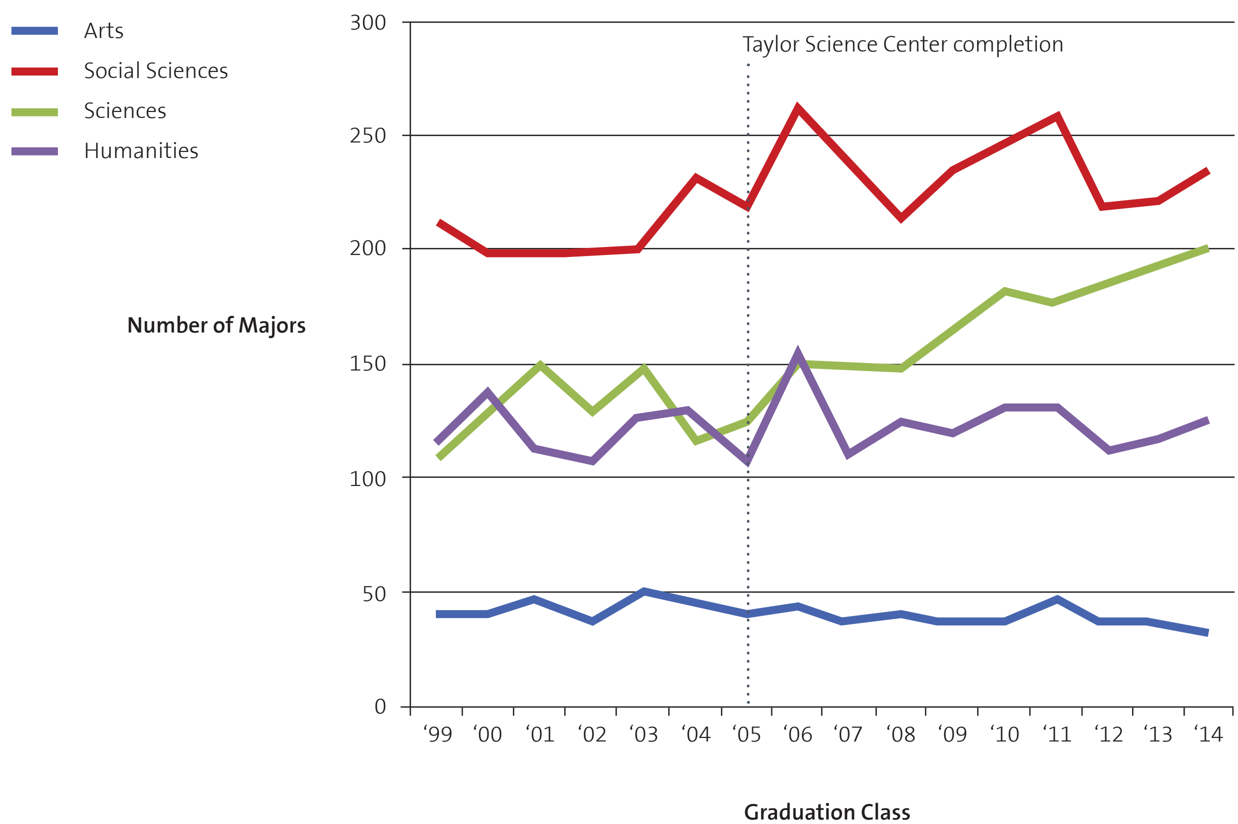
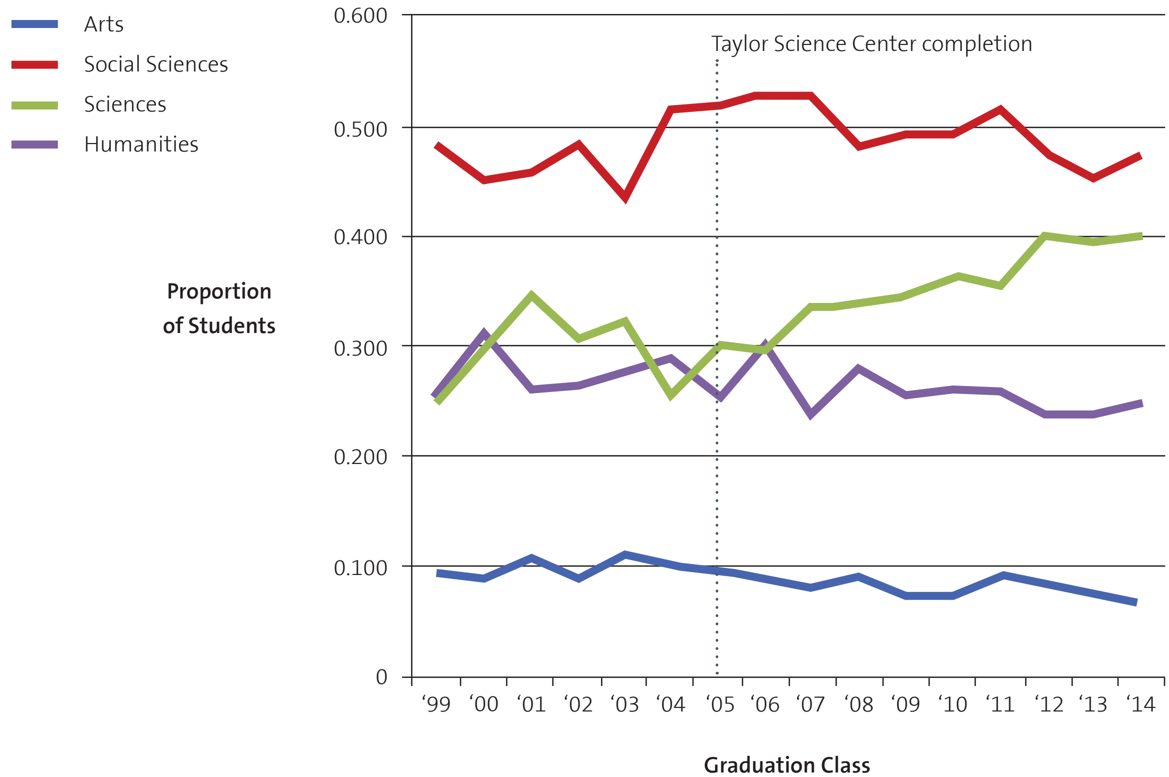


Figure 6: Proportion of Majors by Subject Area by Graduation Class; 1999-2014*



**Sum of proportions exceeds 100 because of double majors.*

To see where the increase in majors occurred within the sciences, we tracked the number of majors by discipline for the same period, as shown in Figure 7. Because of the small numbers per discipline, the trend lines are more variable than in Figures 5 and 6. When we compare the mean number of majors from 1999 to 2006 with the mean number of majors since 2006, all but one of the science majors (geoscience) increased, as shown in Table 2. The largest absolute increases were in biology, environmental studies, neuroscience, and mathematics, which account for 83 percent of the increase in science majors after 2006.

Figure 7: Number of Majors by Science Discipline by Graduation Class; 1999-2014

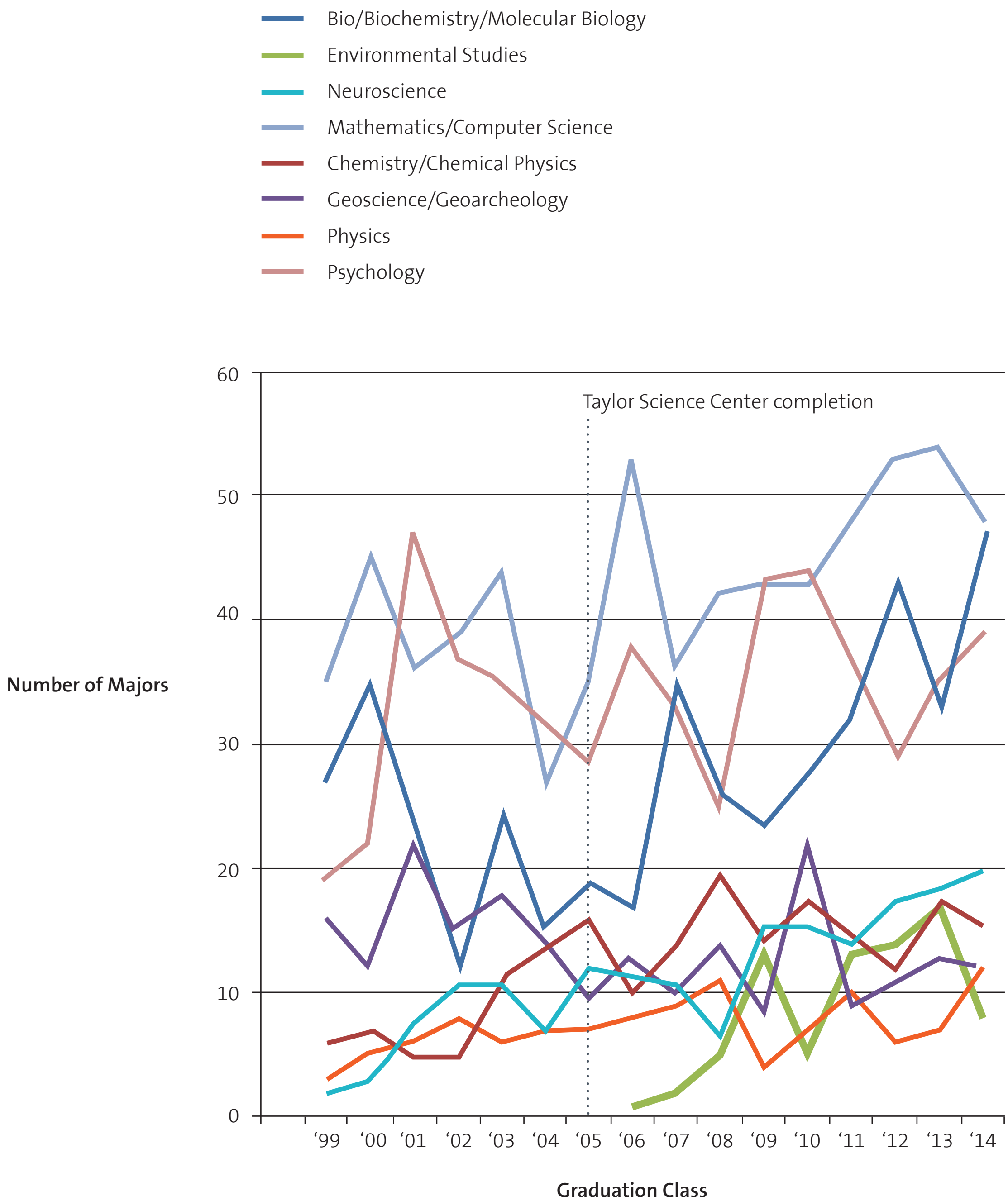


Table 2. Range and Mean Number of Majors by Discipline, 1999-2006 and 2007-2014.

Majors	1999-2006		2007-2014		
	Range	Mean	Range	Mean	Change
Bio/Biochemistry/Molecular Biology	12 – 35	21.38	23 – 47	33.38	+12.00
Chemistry/Chemical Physics	5 – 16	11.00	12 – 20	15.38	+4.38
Environmental Studies*	1	0.12	2 – 17	9.62	+9.50
Geoscience/Geoarcheology	9 – 22	14.88	8 – 22	12.38	–2.50
Neuroscience	2 – 12	8.12	6 – 20	14.50	+6.38
Physics	3 – 8	6.25	4 – 12	8.25	+2.00
Mathematics/Computer Science	27 – 53	39.25	36 – 54	45.88	+6.63
Psychology	19 – 47	32.25	25 – 44	35.50	+3.25

**Major introduced in 2005; first degree conferred in 2006.*

What else, besides the TSC, could account for these changes? One possibility is that changes in major requirements have encouraged more students to enroll in the sciences. At Hamilton, however, major requirements across the sciences have remained relatively stable over the past 15 years. A second possibility is that the increase in science majors is due in part to an increase in double majors. The number of double majors averaged 70.6 per year from 1999 to 2006, but increased to 92.6 per year after 2006. An examination of the double majors in 2013 and 2014 shows, however, that 30 percent of double majors include a major in science, which is less than the 40 percent of all majors that are in science.

It is also possible that increases in science majors reflect national trends. Data compiled by the National Center for Educational Statistics on bachelor's degrees conferred at all U.S. degree-granting institutions indicates a 33 percent increase in degrees in the natural sciences and mathematics between 2005-06 and 2011-12.[3] Biology increased by 32 percent; chemistry by 27 percent; geology and earth sciences by 54 percent; and physics by 22 percent. Moreover, among broad subject areas during this same period, only the natural sciences and mathematics showed an increase in the percentage of degrees conferred, from 7.1 to 7.9. Both the humanities and the social and behavioral sciences declined in percentage of degrees conferred. On the other hand, at least half of the 33 percent national increase in degrees conferred in the natural sciences and mathematics is due to an increase in total degrees conferred. By comparison, Hamilton's overall increase of 31 percent in science and math majors between 1999-2006 and 2007-2014 occurred with a relatively constant number of degrees conferred. Therefore, the increase in majors exceeds national trends almost twofold, and it seems likely that this is due, at least in part, to the construction of the TSC.

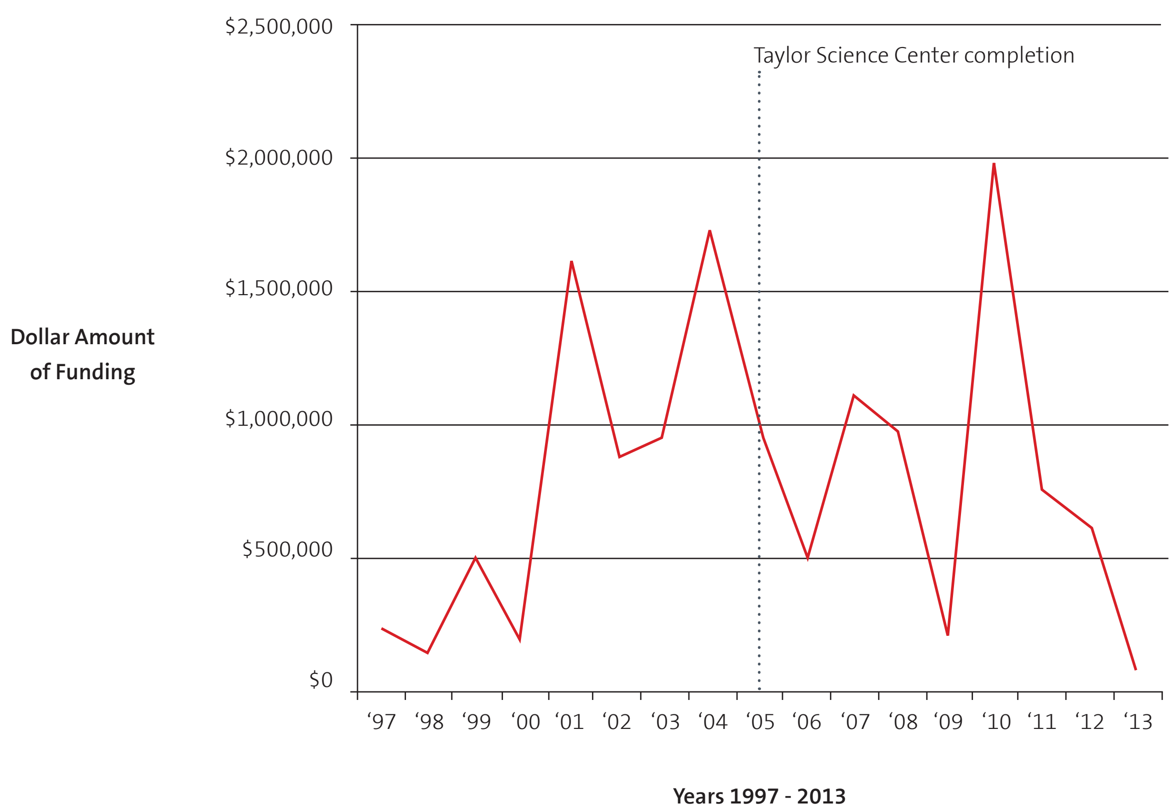
Goal 3. Advance faculty and student research.

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 8 shows the amount of grant money awarded in the sciences from 1995 to 2014. 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 TSC on grant support, therefore, we must examine funding over a much longer period of time.

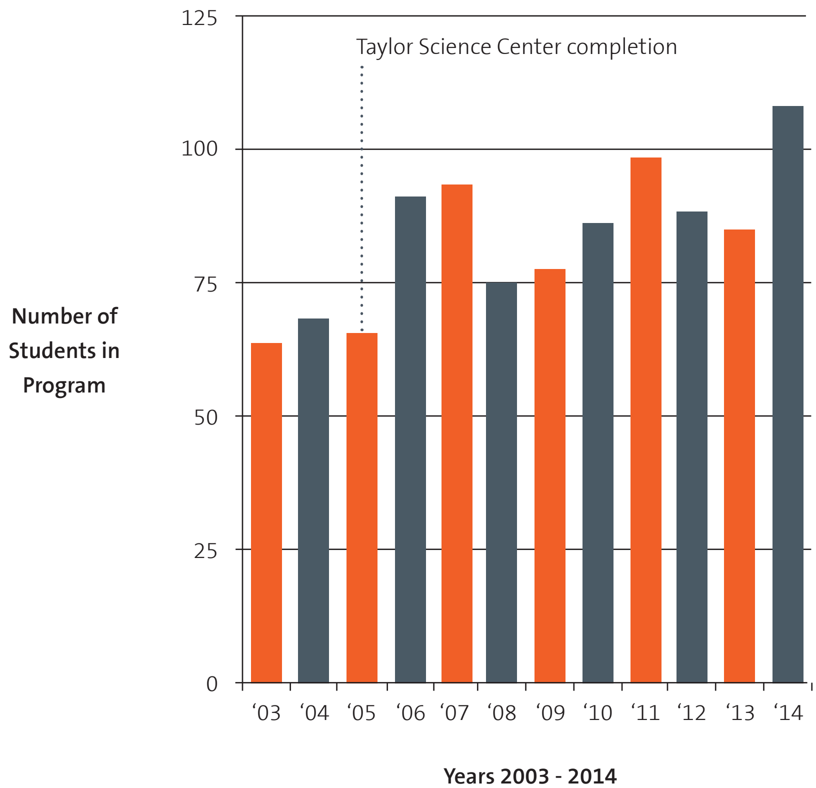
Figure 8: Dollar Amount of Research Grants in the Sciences by Year; 1997-2013



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

For many years, science majors at Hamilton have had the opportunity to participate in a summer research program. In general, these students perform the role of research assistant, offering critical support for faculty research, while gaining valuable research experience. As Table 3 shows, the number of students in the program increased substantially, from 61 to 87 students, in 2006, the first summer after the completion of the TSC. Since then, an average of 86 students have participated annually.

Table 3. Number of Student Participants in Summer Research Program in the Sciences, 2003-2014.



The number of students who take part in the summer program depends on amount of intramural and extramural funding, physical resources such as laboratory space, and the level of student interest. The large increase in student participants that occurred in 2006 cannot be attributed to the level of funding, which did not change significantly from 2005 to 2006. In fact, extramural funding in 2003, 2004, and 2005 exceeded extramural funding in 2006 (see Figure 8). Endowed funding increased incrementally before and after the opening of the building, but the sharp increase in the number of students after it opened was not the result of any special gifts or infusion of funds for summer research at that time. What changed was the faculty's ability to develop more and bigger projects and house more students with better labs and equipment and thus draw on funds that were basically unused.

Two scientists with whom we spoke, who have been at Hamilton since the early 1990's, believe that the new science building has had a significant impact on the growth of the summer research program. Prior to the new science center, they said, labs were hot, cramped and dingy. Projects were literally "spilling out into the hallways." The new, larger, cooler, more technologically advanced labs made summer research much more attractive to both faculty and students. (These two faculty members also believe the new building has helped attract better, somewhat more science-oriented students to Hamilton—that is, students who are more inclined to do summer research.)

/ Summary and Conclusions

Using trend data from various administrative offices, we examined the extent to which construction of the Taylor Science Center at Hamilton College has met three broad goals: (1) made the college more competitive in attracting students, (2) enhanced students' interest in science, and (3) advanced faculty and student research.

The data provide positive support for all three goals. When we examined the number of applications for admission from 1988 to 2014, we found two disruptions in the trend line: the first beginning in 2001, when the College instituted an "open" curriculum; and the second beginning in 2007, two years after the construction of the TSC. Applications increased by about 700 after the curriculum change and by about 480 after the Science Center construction. Additional data from the Admitted Students Questionnaire further support the effect of the Center. The majority of respondents rate "quality of academic facilities" as very important in making their college choice. Prior to 2006, students rated Hamilton lower than comparison schools on this dimension; however, beginning in 2006, students rated Hamilton as higher. Over a 20-year period (1995-2014), we also found a steady increase in mean Verbal and Math SAT scores beginning in 2001. As this occurred prior to construction of the TSC and has continued afterward, we cannot say whether or how much the new building has contributed to the increase.

If the Center draws student applications, and if it generally attracts admitted students to the sciences, we should see an increase in the number of students enrolling in introductory science courses. Tracking enrollment in 100-level science and math courses from 2000-01 to 2013-14, we found an expected increase in 2006-07, one year after completion of the TSC. Prior to construction, fewer than 1,400 students enrolled annually in 100-level science and math courses; this number jumped to more than 1,500 after construction, and exceeded 1,600 in the last two years. Consistent with this effect, we also found an increase in the number of students majoring in science and math, with a lagged effect beginning with the class of 2007. About 30 percent of Hamilton graduates majored in science or math prior to construction of the TSC; since then, this percentage has risen steadily, reaching 40 percent in 2012. The number of majors increased in every scientific discipline except geoscience, with the largest occurring in biology and environmental science.

Data on grant funding in the sciences show that the amount of grant support varies markedly from year to year, and so these data must be examined over a long period of time to discern clear patterns. On the other hand, data tracing the number of students involved in the summer research program in the sciences showed a marked increase beginning in the summer after the TSC was completed. That increase, several Hamilton scientists believe, is due to the new building.

Footnotes

1. See, for example, Don Hossler, Jake Gross, and Brandi Beck, “21st Century Trends in College Admissions and Enrollment,” *College Board National Forum*, 2009. Available: http://www.collegeboard.com/events/repository/225.pdf (accessed 7 July 2015).

2. We applied two statistical analyses that generally support this interpretation. The first is based on first-differenced data, which reformat the data into changes from year to year rather than levels. When regressions are run on first-differenced data, the first disruption or break in the times series (apparently due to the effect of the curriculum change) is statistically significant, and the second break (apparently due to the construction of the TSC) is positive, albeit nonsignificant. (See J. D. Hamilton, *Time Series Analysis*, NJ: Princeton University Press, 1994.) The second approach, Zivot-Andrews tests, which identify breaks in the data, showed stronger support for the second break (i.e., the TSC) than the first. (See E. Zivot and D.W.K. Andrews, “Further Evidence on the Great Crash, the Oil-Price Shock, and the Unit-Root Hypothesis,” *Journal of Business and Economic Statistics*, Vol. 10, 1992, pp. 251-70.)

3. See Institute of Education Sciences, National Center for Education Statistics, D*igest of Education Statistics*, 2013, Table 318.20 (Bachelor’s, master’s, and doctor’s degrees conferred by degree-granting institutions, by field of study: Selected years, 1970-71 through 2011-12) for “natural sciences and math,” and Tables 325.22, 325.65, and 322.72 for specific disciplines.

/ Acknowledgments

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