FINAL REPORT

Pilot Curriculum Evaluation Committee

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EXECUTIVE SUMMARY

The Pilot Curriculum is a long-range experiment in the College of Arts and Sciences, designed to test an alternative to the College's current general education curriculum. Beginning with the class of 2004, students selected into the Pilot Curriculum were not required to meet the standard College degree requirements, but instead fulfilled an alternative set of requirements characterized by (1) a more concentrated and more compact set of general education requirements (four interdisciplinary courses instead of the ten-course General Requirement), (2) an increase in the number of free electives, (3) an emphasis on planning with an academic advisor (including development of an Academic Plan during the sophomore year), and (4) a required research experience, normally in the context of the student's major.

The Pilot Curriculum was implemented as a true, randomized experiment. Each year, beginning with the class of 2004, approximately 200 students were randomly selected for admission to the Pilot Curriculum from a pool of pre-freshmen applicants for the program, and the remaining applicants (ranging from 74 to 208) were designated as applicant non-Pilot.

The Evaluation Committee has obtained data through multiple methods, including interviews and meetings with faculty and advisors, focus groups of students, surveys of students, and analyses of student records and course evaluations.

Faculty instructors of Pilot General Requirement courses have generally expressed enthusiasm for these courses. In contrast, student ratings of these courses on multiple dimensions are very similar to ratings for the regular General Requirement courses. There was no difference by Pilot status in the rather high proportion of students who report taking General Requirement courses only because they are required and not because the student is interested. There was also no difference by Pilot status in the relatively low amount of learning reported by students who took General Requirement courses only because required.

Our evidence suggests only limited success in the goal of improved advising for students in the Pilot Curriculum.

Few differences in course choices were found in comparisons between Pilot and non-Pilot students in analyses of data from transcripts and students' self-reports. We found no consistent significant differences by Pilot status in the proportion of students who were earning double majors, dual degrees, sub-matriculation masters, or minors, and no significant differences were found in measures of study abroad, foreign language learning, and several additional learning experiences. As expected, more Pilot students reported research experience. However, the nature and quality of the research experience did not differ significantly between Pilot students and the non-Pilot students who did research.

Analyses of student records showed no significant difference between Pilot and non-Pilot students in the average number of science courses taken, both for all students and for non-science majors. Nevertheless, among non-science majors, Pilot students were significantly more likely than non-Pilot students to have taken fewer than two science courses and to have taken no mathematics or statistics courses. However, it should be noted that, among seniors, Pilot students were not more likely than non-Pilot students to have low scores on the scientific

and quantitative literacy test we developed. There also were no differences by Pilot status in mean scores for the scientific and quantitative literacy test, self-reported science learning, or a variety of measures of interest in science. Our findings suggest that science and quantitative learning is relatively weak for non-science majors in both the Regular Curriculum and the Pilot Curriculum.

There were no significant differences by Pilot status in seniors' ratings of their "entire educational experience at Penn". There was also little or no difference by Pilot status in seniors' rating of how much their Penn education had contributed to a broad variety of intellectual abilities and learning.

In summary, despite substantial differences between the requirements of the Pilot Curriculum and the Regular Curriculum, and despite our extensive evaluation of multiple sources of information on outcomes, we have found little difference in outcomes for Pilot vs. non-Pilot students. The only consistent, significant differences reflected direct effects of requirements: more of the Pilot students participated in research, and more of them took very low numbers of science and math courses. It is striking that extensive analysis did not reveal any other consistent significant differences between Pilot and non-Pilot students in course-taking patterns or self-reported learning.

INTRODUCTION

The Pilot Curriculum is a long-range experiment in the College of Arts and Sciences that was designed to produce information that would be useful in determining the configuration of the next undergraduate curriculum. Developed by the Committee on Undergraduate Education (CUE) during the academic years 1998 to 2000 and introduced with freshman classes starting in 2000, the experiment tests an alternative to the College's current general education curriculum with a subset of students in each class. By tracking and evaluating the academic programs of those students over their entire undergraduate careers compared with students enrolled in the Regular Curriculum, the experiment seeks to understand the effects of the two curricula on the educational choices students make and on their academic achievements over the course of their entire undergraduate careers.

For students in the Pilot Curriculum, the College suspended its standard degree requirements. In their place, it imposed an alternative set of requirements characterized by (1) a more concentrated and compact set of general education requirements, (2) a corresponding increase in the number of free electives, (3) an emphasis on planning with an academic advisor, and (4) a research experience, normally in the context of the student's major.

1. Pilot General Requirement. In place of the ten-course General Requirement of the Regular Curriculum, Pilot students take four courses specially designed to introduce students to interdisciplinary study and to open up a variety of modes of inquiry. Relatively few such courses exist in the regular General Requirement. However, the General Requirement courses taken by the majority of College students are designed to provide a comprehensive introduction to a single major, to cover the territory of that field from a certain vista, and to draw students into further study in that field.

2. Free Electives. Theoretically, the decrease in required General Requirement courses should afford Pilot students a corresponding increase in free electives. In practice, however, this increase is offset to some degree for some students by the fact that there are fewer opportunities to double count Pilot general requirement courses toward major and pre-medical requirements. Also, Pilot students were not able to substitute AP credit for their General Requirement courses, as students in the Regular Curriculum often could. Consequently, some Pilot students found that they had no more free electives or flexibility in their schedules than they would have had if they had enrolled in the Regular Curriculum.

3. Academic Plan. In general, arrangements for academic advising for students in the Pilot Curriculum are similar to arrangements for students in the Regular Curriculum. Like students in the Regular Curriculum, Pilot students are required to meet with their academic advisors at least three times during the freshman year. Unlike students in the Regular Curriculum, however, Pilot students are expected to prepare a written Academic Plan in consultation with their advisor. Discussions about the plan are normally concluded in the second semester of the sophomore year, which is also the time by which all students are expected to declare a major. The advisor's signature is required, not to indicate approval of the plan but rather to signify that the student has been sufficiently reflective about his or her goals to commit them to writing, has discussed them with a more mature scholar and has responded to observations and suggestions the advisor may have about the plan.

4. The Research Requirement. The purpose of the research requirement is to ensure that all students in the Pilot gain some degree of hands-on experience with the processes of discovering and validating knowledge in at least one field of study. The normal expectation is that this experience takes place within the field that one has studied most thoroughly, namely, the major. Nevertheless, some students arrange to meet this requirement outside their major.

In summary, the objective of the experiment is to see how Pilot students as compared with students in the Regular Curriculum make use of this alternative curriculum to shape interesting, intellectually engaged and coherent programs of study.

Experimental Design

It is unusual for a college to implement a new curriculum on an experimental basis for only a subset of potential students. It is, perhaps, unique that the College chose to implement this curriculum as a true, randomized experiment. Each May starting in 2000, the College sent brochures to the approximately 1600 matriculating freshmen describing the Pilot and the Regular curricula and inviting them to apply for the Pilot Curriculum or to indicate that they would pursue the Regular Curriculum. The brochure explained that 200 students admitted each year to the Pilot Curriculum would be selected at random from the applicants. Comparison of the applicants versus the non-applicants revealed no significant differences in the standard academic indicators (SAT-V, SAT-M, and a "Predictive Index" computed by the Penn Admissions Office to predict students' first semester GPAs). No bio-demographic differences (sex, ethnicity, etc.) were evident except for a slightly higher proportion of first-year Pilot applicants whose country of origin was outside the United States.

In each year, the goal was to recruit a pool of 400 applicants, from which to randomly select 200 for the Pilot Curriculum and 200 for the primary control group, namely, those who applied for the Pilot Curriculum but who were not selected. In some years, as shown in Table A.1, the number of applicants was substantially less than 400, leaving a control group somewhat smaller than 200. In all years, the selection method was by simple random sampling.

Although the virtues of a randomized experiment will be evident to many, it is worth emphasizing what this methodology accomplishes. If we had merely selected the first 200 applicants in each cohort and compared them with all other students in their cohort, any differences we observed in their educational experiences and achievements could potentially be attributed to differences in such things as attitudes, motivations, and abilities that existed prior to their arrival at Penn. On the other hand, since participants in the Pilot Curriculum were randomly chosen from among all who applied, differences in their educational experiences and achievements and those of the applicants who were not chosen can be only be attributed to their differing curricular regimes .

In many of our research projects, we compared three groups of students: Pilot students, students who applied for the Pilot Curriculum but were not selected, and students who did not apply for the Pilot Curriculum. These comparisons are referred to as comparisons by Pilot status.

Table A.1 Numbers of Applicants and Non-applicants to Pilot Curriculum

	Applicants	Non-applicants	Total Responses to Invitation	Selected for Pilot	Not Selected
Class of 2004	279	975	1254	205	74
Class of 2005	416	944	1360	208	208
Class of 2006	350	930	1280	206	144
Class of 2007	362	1005	1367	200	162

Evaluation Committee

In the spring of 2000, CUE called for the creation of a separate and independent Pilot Curriculum Evaluation Committee consisting of four faculty members and a student. Three faculty candidates for the Committee were vetted by the Undergraduate Chairs. The fourth candidate was selected by CUE from among those of its own members whose terms were about to expire and who were intimately acquainted with the formulation and development of the idea for the Pilot Curriculum. A member of the College Dean's staff served ex officio.

The Evaluation Committee has been accumulating data from this experiment over the past four years, primarily from the first and second cohorts of Pilot students. In April of this year we submitted an interim report of our findings to date. Since then we have undertaken the following additional studies.

- Additional statistical analysis of student records:
    - Courses taken outside of SAS by Pilot status.
    - Number of courses taken in major subject by Pilot status.
    - Analysis of data for the class of 2005.

- Additional surveys of seniors in the spring and fall of 2004 which included questions concerning students' research experience and required courses, as well as replications of our earlier evaluations of students' educational experiences and the Science Survey. Our analyses of these survey data included not only comparisons by Pilot status, but also some comparisons between science and non-science majors.

- Analysis of Course Evaluation Form data to evaluate how reported amount learned relates to whether students are taking a course to satisfy a requirement.

- Content analysis of Academic Plans for the class of 2005.

- Identification of regular General Requirement courses that are similar in structure and content to Pilot General Requirement courses.

- Analysis of trends in Pilot General Requirement course offerings and ratings for individual courses.

This report is organized in the following way. We begin with a Summary Report that presents our findings in each of several content areas: Pilot General Requirement courses, pre-major advising, patterns of course choices, students' assessment of their education, science education, and the research requirement. This is followed by Research Project Reports which provide more detailed descriptions of the various projects we conducted over the past four years, along with discussions of specific findings. In the Summary Report, numbers in parentheses refer to the section numbers of the research projects that provided the relevant information.

Note that in some sections of the report, we have not only evaluated the Pilot Curriculum, but have also investigated some related issues concerning general education, including the effectiveness of required courses and science learning by non-science majors. We believe that our findings in these areas will contribute to a discussion of possible curricular changes in the College of Arts and Sciences.

SUMMARY REPORT[1]

Pilot General Requirement Courses

For the General Requirement component of the Pilot Curriculum, students choose from a small set of interdisciplinary courses selected and designed for the purpose of general education. Unlike most courses in the regular General Requirement, Pilot Curriculum General Requirement courses are designed to suggest a variety of areas for further study and modes of inquiry rather than to introduce students to the field and disciplinary methods of a single major. Students are required to take fewer of these courses, four instead of the ten General Requirement courses students must take in the Regular Curriculum.

The first four Pilot General Requirement courses were offered in the fall of 2000 and had a total of 10 faculty instructors. These faculty were interviewed in spring 2001 about their experiences in the courses (5). Faculty were generally very positive about the courses. Those who taught in teams were particularly enthusiastic about the quality of the intellectual experience, but mentioned the additional work required to prepare for the classes and coordinate their efforts with other members of the team. Similar views were expressed in a forum of faculty who taught Pilot courses in 2000 or 2001.

Students had less favorable views about the Pilot General Requirement Courses. Focus groups of randomly chosen Pilot students held in 2000 and 2001 expressed both positive and negative opinions about the courses (6). Complaints centered on the workload, which some students found excessive, and the lack of integration in the team-taught courses. Many students were unhappy with the limited choice of courses.

To get a quantitative assessment of student satisfaction, supplementary course evaluations were distributed in all Pilot General Requirement courses (2). For courses taught in 2002, we used both standard and supplemental evaluation forms to compare 15 Pilot general requirement courses with a selected sample of 28 General Requirement courses taught in the Regular Curriculum. Based on the standard evaluation forms, there was little if any difference between courses in the two curricula with regard to students' overall evaluation of either the course or the instructor. For the supplemental evaluation (for which we had reports from only 12 Regular Curriculum courses), none of the differences between Pilot courses and regular courses was statistically significant.

Pre-Major Advising

One goal of the Pilot Curriculum was to improve academic advising during the first two years. Specifically, two consequences were hoped for: (a) that the reduced number and complexity of general education requirements would allow more time for advisors and Pilot students to have

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[1] Numbers in parentheses refer to the section numbers of the Research Project Reports that provided the relevant information.

meaningful conversations about academic goals and planning;(b) that the required Academic Plan during the sophomore year would focus thoughtful attention on planning and achieving academic and intellectual goals.

Academic advisors for Pilot students reported that they felt these goals were achieved to some extent, and they indicated that advising Pilot students was more satisfying and challenging than advising non-Pilot students. At the same time, the advisors often felt unprepared to provide practical recommendations in response to questions about academic interests (7). Correspondingly, both Pilot and non-Pilot seniors complained about poorly informed advisors (3). Seniors reported considerable dissatisfaction with advising during their first two years at Penn and this did not differ significantly by Pilot status (3).

Among the advisors of Pilot students who responded to our e-mail survey, most viewed the writing of the Academic Plan as a beneficial exercise. These advisors felt that the preparation of this Plan made students focus on the educational opportunities available at Penn and it helped guide discussions between the student and the advisor. Most of these advisors recommended that this requirement be extended to all undergraduate students in the College (8). Pilot students were not as positive about the Academic Plan. About half of the students believed that the Plan had not helped them make better course choices (8), and some students considered it redundant with planning for the major (6). The usefulness of the Academic Plan may have been limited by the tendency of students to focus on courses that had already been taken, with relatively little attention devoted to plans for future selection of elective courses (8).

In summary, our evidence suggests only very limited success in the goal of improved advising for students in the Pilot Curriculum. One pervasive problem is how to provide advisors and students with helpful information on the enormous array of academic options available to students in the College. Advising in the Pilot Curriculum framework might be improved by efforts to focus the Academic Plans on the future more than the past.

Patterns of Course Choices

One of the major goals of the Pilot Curriculum was to allow students greater freedom to choose courses to pursue their intellectual interests by reducing the number of general education courses required. In student focus groups, students often said that they had applied for the Pilot Curriculum because it has fewer general education requirements and thus provides greater freedom to choose electives than the Regular Curriculum (6). Nevertheless, few differences in course choices were found in comparisons between Pilot and non-Pilot students in analyses of data from transcripts and students' self-reports (1).

No significant differences by Pilot status were found in the proportion of students who were earning double majors, dual degrees, sub-matriculation masters, or minors, and no significant differences were found in measures of study abroad, foreign language learning, and several additional learning experiences (3). One significant difference was that more of the Pilot students reported a "research-oriented independent study or other research experience" but this is unsurprising since the Pilot Curriculum requires a research experience. Another difference

was that more Pilot students reported a "culminating senior experience (comprehensive exam, capstone course, thesis, etc.)", which probably relates to the research experience requirement, since research experience correlated strongly with participating in a culminating senior experience.

One concern about the Pilot Curriculum has been that non-science majors in the program might take fewer natural science and math courses, given that they have fewer requirements in that area. Analyses of student records showed no significant difference between Pilot and non-Pilot students in the average number of science/math courses taken, even among the subgroup of students who were not science majors. Nevertheless, among non-science majors, Pilot students were significantly more likely than non-Pilot students to have taken fewer than two science courses and to have taken no mathematics or statistics courses (1).

We found no evidence for differences between Pilot and non-Pilot students in the average number of courses taken in the major and the average number of courses taken outside the College of Arts and Sciences.

Students' Assessment of Their Education

There were no significant differences by Pilot status in seniors' ratings of their "entire educational experience at Penn". There was also little or no difference by Pilot status in seniors' ratings of how much their Penn education had contributed to a broad variety of intellectual abilities, including "thinking critically and analytically", "ability to formulate original ideas and solutions", "writing clearly and effectively", "using quantitative tools", and understanding in humanities, social sciences, or natural sciences (3).

Self-reports in our Senior Surveys indicate that a substantial number of courses are taken only to fulfill a requirement, with relatively little self-reported learning in many cases (3). These problems were especially serious for the General Requirement (both regular and Pilot) and for the Quantitative Data Analysis Requirement and Writing Requirement. These problems did not differ by Pilot status. In contrast, Course Evaluation Form data suggest more learning by students who took courses to satisfy the General Requirement (3). One likely reason is that the Course Evaluation Form data include students who took a course not only to satisfy a requirement, but also for interest. There was a great deal of variation in reported amount learned in different General Requirement courses, with some courses receiving quite low ratings. These findings suggest that the effectiveness of general education might be increased if we could develop required courses that stimulate the interest of more of our students, and either improve less effective courses or remove them from the General Requirement.

Natural Science and Quantitative Skills Education

To evaluate scientific and quantitative literacy, we developed and validated a multiple-choice "Science Survey" which assessed scientific reasoning, understanding of concepts, and knowledge of important facts and terminology in the natural sciences and math/statistics. There were no significant differences between Pilot and non-Pilot seniors in either the mean score or the proportion with low scores on this scientific and quantitative literacy test (4). Data

for seniors also indicated no significant difference by Pilot status in several measures of science interest, including scores on a Science Interest scale, average number of science and math courses taken at Penn, or whether or not students had a natural science or math major (1, 4). Thus, we found no difference by Pilot status in science and math education outcome measures, although, as mentioned above, Pilot students were more likely than non-Pilot students to take fewer than two science courses and no math or statistics courses. Our findings also suggest relatively weak science and quantitative learning by non-science majors in both the Regular Curriculum and the Pilot Curriculum (3,4).

Research Requirement

One of the goals of the Pilot Curriculum is to offer students significant opportunities for individual research, scholarship and/or creative projects, and all Pilot students are expected to engage in research prior to graduation. In contrast, research is optional for many students enrolled in the Regular Curriculum, although it is required in some majors. As expected, more Pilot seniors than non-Pilot seniors reported that they had conducted research, and that they had done so as a Pilot requirement (3, 9). The most common reasons that non-Pilot students reported for not doing research included not having enough time due to other course requirements or non-academic activities and not being interested in doing research (9).

Pilot students can fulfill the research requirement in a number of ways – by taking upper level research seminars, independent studies, writing a senior thesis, or conducting lab research or experiments – and they can usually do so in the context of their major. Unfortunately, this was not always clear to first and second-year Pilot students who expressed some frustration about lack of information regarding how they could fulfill the research requirement.

Given considerable variation in departmental undergraduate research opportunities, which are related to disciplinary considerations and the number of undergraduate majors, the nature of students' research experiences are likely to vary substantially. A survey of graduating seniors in the spring of 2004 confirmed the expected diversity in types of research, with substantial proportions of Pilot students reporting laboratory research, interview or questionnaire collection of data, ethnographic or observational field research, archival research of original documents, and/or textual analysis. This survey also showed that the type of research Pilot students engage in does not differ significantly from the type of research conduced by non-Pilot students, and the average rating of the quality of the research experience did not differ by Pilot status.

In summary, the research requirement in the Pilot Curriculum resulted in a higher proportion of students engaged in research. The self-reported nature and quality of the research experience was similar for Pilot and non-Pilot students.

RESEARCH PROJECT REPORTS

1. Analyses of Student Records

One of the rationales for the Pilot Curriculum was that a reduced number of General Requirement courses would make it possible for students to create a curriculum tailored to their specific interests with the expanded number of elective credits available to them. In this section, we will examine what students have actually done with their course choices. Using archival records for the class of 2004 and the class of 2005, we compare the course taking patterns of students enrolled in the Pilot Curriculum with those of students who applied for the Pilot Curriculum but were not chosen ("applicants") and students who chose not to apply ("non-applicants").

For the class of 2004, the analysis covers courses taken in the first through fourth years of residence at Penn. As of June 2004, 84 percent of these students had graduated from the College, a number that did not differ significantly by Pilot status. Of the 240 students who had not graduated, 123 had not completed their degree but were still active. Those students are retained in the analysis. The remaining students had prematurely terminated for a variety of reasons, including withdrawals and internal transfers to other schools. Those 117 students were excluded from further analysis. Of the 1401 remaining students, 183 were Pilot students, 66 were applicants, and 1152 were non-applicants.

For the class of 2005, the analysis covers courses taken in the first through third years of residence at Penn. Because information on premature termination was not immediately available for this class, we simply eliminated any students who had completed fewer than 18 course units during that three-year period. Among the remaining students, there were 176 Pilot students, 185 applicants, and 1048 non-applicants.

Table 1.1 compares students on several dimensions related to course-taking patterns. Because Pilot students generally have more free electives to work with, we reasoned that they would be more likely to double or triple major, pursue dual degrees, or submatriculate in graduate programs. The first three rows of Table 1.1 show little or no evidence for those expectations. The last column in the table is a *p*-value for testing the null hypothesis that there are no real differences among the three groups for each outcome. A *p*-value less than .05 is usually taken as statistically significant evidence that there are real differences. For the class of 2005, Pilot students are somewhat more likely than the other two groups to have more than one major. But the difference between Pilot students and non-Pilot applicants is *not* statistically significant (the second *p*-value is .44), and this is the more trustworthy comparison.

A major concern about the Pilot Curriculum has been that students in the program would take fewer natural science courses, given that they are only required to take one General Requirement course in Category 3 "Earth, Space and Life" and another in Category 2 "Science, Culture and Society." To evaluate this possibility, we classified courses taken by students as "science" if the course was taught in one of the following departments: astronomy, biochemistry, bioengineering, biological basis of behavior, biology, biomedical studies, cell and molecular biology, chemistry, cognitive science, computer science and engineering,

electrical science, engineering and applied science, environmental studies, genomics and computational biology, geology, materials science and engineering, mathematics, mechanical engineering and applied mechanics, physics, psychology, or statistics. Note that for this analysis, we have included mathematics and statistics in the science category, although we also break out math courses separately. Majors were classified as science majors if they were in any of these departments. For Pilot students, we also treated any course labeled COLL003 (the earth, life and space category) as a science course. However, we did *not* include COLL002 courses (the science, culture and society category) because we were concerned that some faculty might question whether these courses have enough science content to be considered science courses. Note, also, that none of these counts includes AP credits.

Table 1.1 Comparisons Between Pilot Students, Applicants and Non-Applicants, Class of 2004 and Class of 2005.

	Class	Pilot	Unselected Applicants	Non-Applicants	*p*-value[a]
More than one major	2004	27%	26%	22%	.30
	2005	33%	29%	24%	.02 (.44)
Dual Degree	2004	4%	5%	5%	.92
	2005	6%	5%	5%	.94
Submatriculation	2004	3%	3%	2%	.49
	2005	2%	2%	1%	.82
Science Major	2004	26%	24%	27%	.95
	2005	34%	26%	29%	.23
Mean # Science Courses (all students)	2004	8.2	8.3	8.4	.95
	2005	6.9	7.1	7.2	.82
Mean # Science Courses (science majors)	2004	20.0	18.8	17.8	.30
	2005	13.2	15.3	14.7	.02 (.01)
Mean # Science Courses (non-science majors)	2004	4.1	5.0	4.5	.17
	2005	3.6	4.3	4.1	.15
0 or 1 science courses (non-science majors)	2004	28%	6%	4%	<.0001
	2005	22%	9%	7%	<.0001
No math or stat courses (non-science majors)	2004	54%	14%	20%	<.0001
	2005	41%	23%	21%	<.001
Mean # courses in major	2004	11.2	10.7	10.4	.25
	2005	7.3	7.5	6.4	.23
Mean # courses taken outside SAS	2004	2.8	2.8	3.0	.82
	2005	1.8	1.9	2.0	.71

[a]The *p*-value is the probability of getting percentages or means that are this different (or more) across the three groups through chance alone. A *p*-value below .05 is conventionally regarded as a statistically significant difference. Where a second number is given in parentheses, the comparison is only between Pilot and non-Pilot applicants.

Under this definition of science, we see that the percentage of students who majored in science is about the same for all three groups. More generally, in other analyses not shown, we found no evidence for Pilot students to choose different majors than non-Pilot students.

With regard to average (mean) number of science courses completed, the differences were far from statistically significant. (Note that the means for the class of 2005 are markedly lower because they only had three years of course data rather than four). Of course science majors are *required* to take multiple science courses, so the real issue is how the non-science majors compare across the three groups. Among the non-science majors, there is some tendency for Pilot students to take fewer science courses but the differences are not quite statistically significant. Surprisingly, among the *science* majors, there is a statistically significant tendency for Pilot students to take fewer science courses for the class of 2005, but not for the class of 2004.

Although the average number of courses is quite comparable across the three groups, there are notable differences at the lower end of the distribution. Twenty-eight percent of the Pilot students in the class of 2004 who were not science majors took fewer than two science courses, compared with six percent or less of the non-Pilot students, a difference that is highly significant. The differences for the class of 2005 are also highly significant, although not quite as dramatic.

The disparity is even more marked for courses in mathematics or statistics for which Pilot students have no requirement. Among non-science majors in the class of 2004, fully 54 percent of Pilot students took no math/stat courses, compared with around 20 percent or less of non-Pilot students (who presumably satisfied their formal reasoning requirement with AP credit or with courses other than math or statistics). Again, this difference is highly significant. It is replicated for the class of 2005, although differences are not quite as large.

It has been suggested that Pilot students might use their additional electives to take more courses in their major. To evaluate this possibility, we classified courses as in the major if the four-letter registrar's code for the course matched each student's major. This undercounts major courses because, in many cases, courses taken in other disciplines may satisfy major requirements. However, we have no reason to suspect that the undercount would differ by Pilot status. As seen in the penultimate row of Table 1.1, there are no significant differences in mean number of courses taken in the major.

As shown in the last row of Table 1.1, Pilot students are no more likely than non-Pilot students to take courses outside of the College of Arts and Sciences.

Finally, we attempted to get an overall test of whether Pilot students chose their courses in a more concentrated way or spread their choices more evenly across fields and disciplines. To do this we classified courses as falling into nine areas (in part mimicking the General Requirement sectors): arts and letters, history and tradition, social sciences, biological sciences, physical sciences, foreign language, area studies, Wharton, and not otherwise classified. For each student, we then calculated an index of dispersion of their course choices across these nine

areas.[2] This index could range from .09 for a perfectly even distribution to 1.0 if all courses were taken within a single area. The mean index value among all students was .27 for the class of 2004 and .26 for the class of 2005. However, there were virtually no differences by Pilot status.

[2] The index of dispersion was calculated as follows: Compute the proportion of courses that a student took in each area. Square each proportion and sum over all areas.

2. Evaluation of General Requirement Courses

The most visible component of the Pilot Curriculum is the set of special courses designed for Pilot students to satisfy the General Requirement. Several of these courses have been offered each semester since the fall of 2000. In this section, we (a) examine patterns of course offerings and terminations of Pilot General Requirement Courses, (b) compare student evaluations of Pilot General Requirement courses with those for regular General Requirement courses, and (c) examine trends in evaluation of Pilot General Requirement courses over time.

Courses Approved for the Pilot Curriculum General Requirement

Table 2.1 shows the number of courses approved for the Pilot Curriculum General Requirement, broken out by numbers of instructors, frequency of offering, and numbers of terminated courses.

Table 2.1 Pilot Curriculum General Requirement Courses: Number of Instructors, Frequency Offered, and Terminated Courses

Pilot courses offered over 10 semesters

	Repetitions				
# Instructors	4x	3x	2x	1x	Total
3	2	1	1	4	8
2	0	1	7	5	13
1		6	10	6	22
	2	8	18	15	43

Terminated pilot courses

	Repetitions				
# Instructors	4x	3x	2x	1x	Total
3			1	4	5
2			1	2	3
1				1	1
	0	0	2	7	9

Over the past five years, the Pilot Curriculum General Requirement Committee approved 43 distinct courses. Of these, 34 were brand new courses or involved significant revisions to pre-existing courses. The other 9 were pre-existing courses requiring less adaptation for the Pilot. These 43 courses were offered on a total of 83 occasions during the ten semesters of the Pilot (through spring 2005).

Of these 43 courses, 10 were offered 3 or more times, 18 were offered twice, and 15 were offered once. Of the 15 offered once, 5 were new to the Pilot during the current academic year (2004-2005). Of the remaining 10 one-time courses, 2 are expected to be offered on an every-other-year basis, and 1 is on hold while one of the two instructors takes on other

responsibilities. The other 7 are not expected to be offered again, although one has evolved into a new course, also approved for the Pilot, which the department is committed to offer each year indefinitely.

A total of 9 of the 43 courses will no longer be offered. These include 5 of the 8 taught by a three-person team, 3 of the 13 taught by a two-person team, and 1 of the 22 taught solo. Seven of these 9 will not be offered in part because of faculty departures or retirements.

Comparison of Pilot and Regular General Requirement Courses

We compared student evaluations for all 15 Pilot General Requirement courses taught in the spring or fall of 2002, with a set of 28 courses chosen from the regular General Requirement taught in the Spring of 2002. The 28 Regular Curriculum courses were selected with representation from each of the seven sectors. We tried to choose courses that served as introductions to particular fields and the courses that students are most likely to take in a given sector. But we did not want to include only very large lectures, for that would have introduced a systematic bias in comparison to the Pilot classes, which have fallen in the range of small to medium. Some of the courses chosen (*Devil's Pac*t, for instance) are interdisciplinary in much the same way that Pilot courses are. In fact, two of the courses (*Devil's Pact* and *What Every Lawyer, Businessman and Citizen Needs to Know about Molecular Biology*) have subsequently been approved as Pilot courses.

We first compared the courses using data from standard student evaluation forms distributed in all courses. As shown in Table 2.1, the Regular Curriculum courses tend to be somewhat larger with a median enrollment of 69 students, compared with a median enrollment of 47 for the Pilot courses. This difference is not quite statistically significant, however. Courses from the two curricula are nearly identical in mean rating of the courses, at a little over 2.5. For the instructor ratings, some of the team-taught Pilot courses had the students evaluate each instructor separately. In those cases, we simply used the mean of the multiple ratings. Again, there is little if any difference in mean ratings of the Pilot courses and the regular courses.

We also requested that instructors distribute supplemental evaluation forms that were designed to focus on questions that were particularly relevant to the success of the Pilot courses. We got responses from 14 of the 15 Pilot course instructors, but only 12 of the 28 regular course instructors. With the exception of Psychology 1, we did not obtain the cooperation of faculty teaching the very largest classes--Political Science 1, History 2, Art History 102--which were also courses with aims most in contrast with the Pilot classes. So the factors that differentiate the Pilot courses and the Regular Curriculum courses ended up being less clear than we had wished. To test whether the 12 respondents were a representative subsample of the 28 courses, we compared respondents and non-respondents on available measures from the standard evaluation form. For all measures, the differences were small and not statistically significant.

For five of the six questions that were identical across the forms completed by regular and Pilot course instructors, the Pilot courses were evaluated less favorably by substantial margins. For example, an average of 60 percent of students in the Regular Curriculum courses said the course was somewhat better or much better than other courses they were taking in the semester, while the average for Pilot students was only 47 percent. In Pilot courses, an average of 57

percent of the students said the pace was about right, but in Regular Curriculum courses the average was 69 percent. Because of the small sample sizes, none of these differences achieved statistical significance, although the *p*-values for the two questions just mentioned came close.

Table 2.2 Comparisons of Student Evaluations in Pilot and Regular General Requirement Courses

	Pilot Courses	Regular Courses	*p*-value
Based on standard evaluation forms (*15 Pilot, 28 regular*)			
Median Enrollment	47	69	.14
Mean rating of courses	2.55	2.59	.82
Mean rating of instructors	2.90	2.98	.70
Based on respondents to supplemental forms (*14 Pilot, 12 regular*)			
% Much or somewhat better than other courses	47	60	.08
% Successful at introducing material not covered in high school	75	75	.92
% Effective in understanding materials outside the course	71	77	.19
% Increased interest in learning more	65	78	.33
% Pace about right	57	69	.09
% Course covered topics in sufficient depth	36	42	.37

It is worth observing more generally that in the sectors of the regular General Requirement, a number of courses are potentially approvable (perhaps with some modification) for the Pilot General Requirement. In the first year of the Pilot, a biology course, *Humans and the Environment*, was adapted for the Pilot Curriculum with the creation of new assignments and recitation sessions. Others, such as the *Devil's Pact*, mentioned above, were adopted without modification. According to our estimate, the number of courses that are, or with slight modification could be, approved for the Pilot General Requirement is as follows:

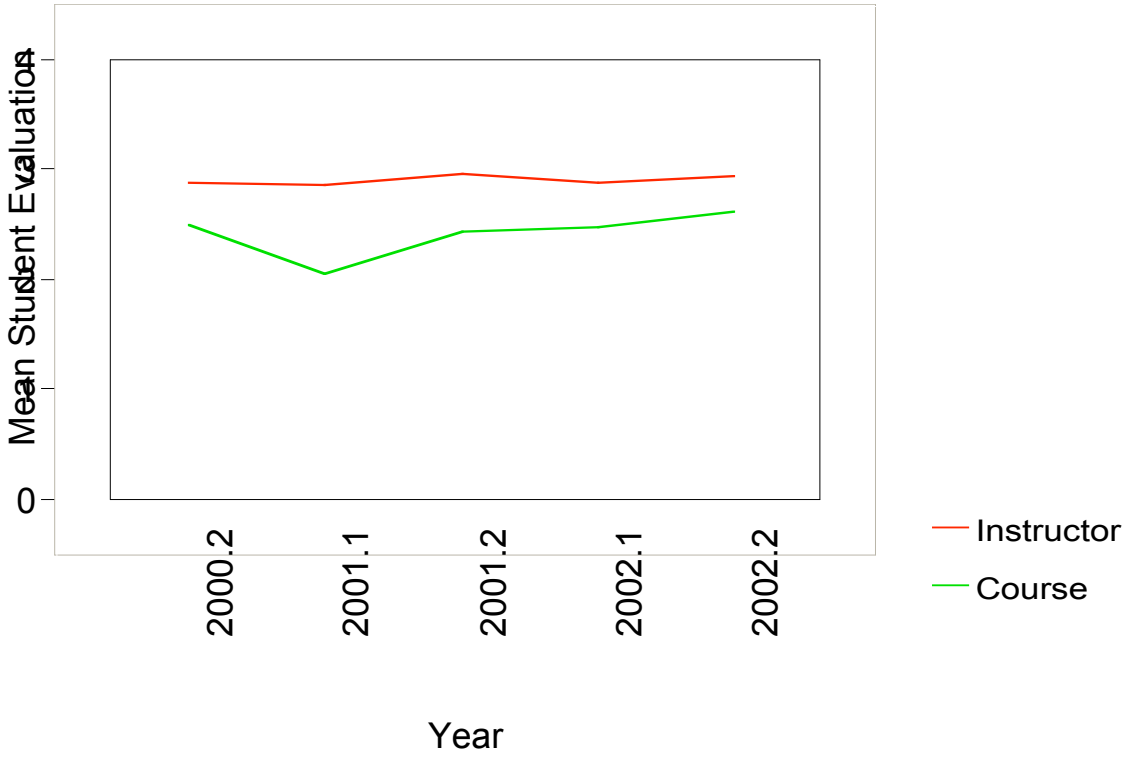
Society	7 of 44
History and Tradition	7 of 65
Arts and Letters	8 of 78
Formal Reasoning and Analysis	3 of 19
Living World	5 of 28
Physical World	4 of 31
Science Studies	4 of 19

Thus, Pilot-like courses constitute between 10% and 21% of the courses in the various sectors of the regular General Requirement.

Trends in Student Evaluations of Pilot General Requirement Courses

In addition to comparing Pilot and Regular Curriculum courses, we also looked at changes over time in student evaluations of the Pilot courses. Figure 2.1 shows the average evaluations of courses and instructors over the first five semesters of Pilot courses. As with student evaluations generally, ratings for instructors are always higher than ratings for courses. But the trend over time is weak, and not statistically significant.

Figure 2.1 Mean Student Evaluations of Pilot Courses and Instructors, By Semester



We also investigated whether individual Pilot courses received better evaluations when they were offered a second time. We have course evaluation data for the first eight semesters of the Pilot Curriculum, during which 38 different Pilot courses were offered. Of these, only 14 were taught more than once. The mean overall course rating of those 14 courses was 2.56 on the first offering and 2.75 on the second, a difference that was not statistically significant. However, looked at another way, 11 of the 14 courses got a better rating on the second evaluation than on the first, which is significantly higher than the 7 that would be expected by chance alone. So there is some evidence for small improvements in the course evaluations. Keep in mind, however, that in most semesters, more than half of the Pilot courses offered were first-time offerings. Thus, whatever improvements occurred in the repeated courses, the experience of students in the first eight semesters was unlikely to be appreciably affected by those improvements. The pattern of course offerings changed dramatically in the current academic year (2004-2005) when 22 out of 27 scheduled courses are repeated from previous years. However, evaluations of those courses are not yet available.

3. Self-Reported Educational Experience

Students' self-reported educational experience was evaluated in three Web-based surveys of seniors, in fall of 2003 and spring of 2004 for the class of 2004, and in fall of 2004 for the class of 2005. (Seniors were defined as students who entered Penn in fall 2000 for the class of 2004 and in fall 2001 for the class of 2005, who were still enrolled at the time of the survey, and who had at least 20 units of course credit.) Numbers of respondents and response rates are given in Table 3.1.

Table 3.1 Samples for Senior Surveys

		Number of Respondents		
Semester	Response Rate	Pilot	Applicant Non-Pilot	Non-Applicant Non-Pilot
Class of 2004[a]				
Fall, 2003	68%	124	32	132
Spring, 2004	50%[b]	99	22	94
Class of 2005				
Fall, 2004	62%	107	102	124

[a] For the Pilot and Applicant Non-Pilot categories, many of the same respondents participated in both the Fall, 2003 and Spring, 2004 surveys.

[b] This response rate differed significantly by Pilot status (57% for Pilot, 41% for Applicant Non-Pilot and 47% for Non-Applicant Non-Pilot). For the other two surveys, response rates did not differ significantly by Pilot status.

Self-reports of participation in thirteen categories of learning experiences showed few differences by Pilot status (Table 3.2). The only difference that was significant in both years was that Pilot students more often reported a "research-oriented independent study or other research experience". This difference was expected because a research experience is required for all students in the Pilot Curriculum, but not in the Regular Curriculum (see section 9). In addition, Pilot students were somewhat more likely to report a "culminating senior experience (comprehensive exam, capstone course, thesis, etc.)". This probably relates to the research experience requirement, since research experience correlates strongly with participating in a culminating senior experience. Responses to a spring 2004 open-ended question concerning the student's most significant accomplishments at Penn included thesis or research, other work produced or coursework, improved skills, and academic honors. These responses did not differ significantly by Pilot status.

Table 3.2 Student Participation in Various Educational Activities -- Fall, 2003 and 2004[a]

Which of the following have you done or do you plan to do before you graduate from Penn?
% Answering Yes (with undecided counted as half each)

2003	2004	
80%	75%	community service, volunteer work, or service learning course
80%	74%	took several courses to pursue another interest (not counting other categories below)
73%[b]	73%[b]	research-oriented independent study or other research experience
70%	65%	practicum, internship, field experience, co-op experience, or clinical assignment
64%	60%	learned a second foreign language or earned a language certificate
61%[c]	63%	culminating senior experience (comprehensive exam, capstone course, thesis, etc.)
60%	61%	minor
50%	40%	courses to prepare for postgraduate work, such as medical school
41%	46%	study abroad
40%	33%	double major or dual degree
37%	43%[d]	took courses to improve your GPA
8%	6%	submatriculation masters
3%	2%	earned a computer certificate

[a] No significant differences by Pilot status were observed for most items; there were two exceptions in each year, as indicated below.
[b] Significantly different for Pilot (91% in 2003, 91% in 2004), Applicant Non-Pilot (62%, 68%), and Non-Applicant Non-Pilot (58%, 62%) ($p = .000$ overall and $p <= .001$ for Pilot vs. Applicant Non-Pilot comparison).
[c] Significantly different for Pilot (72%), Applicant Non-Pilot (55%), and Non-Applicant Non-Pilot (52%) ($p = .004$ overall and $p = .10$ for Pilot vs. Applicant Non-Pilot comparison) (2003, with a similar trend $p = .09$ in 2004),
[d] Significantly different for Pilot (37%), Applicant Non-Pilot (38%), and Non-Applicant Non-Pilot (52%) ($p = .04$ overall, but not significant ($p = .66$) for Pilot vs. Applicant Non-Pilot comparison) (2004).

Seniors indicated considerable satisfaction with their Penn education, but dissatisfaction with advising during their first two years, both in their ratings in all three surveys (Table 3.3) and in open-ended comments in fall 2003 (Table 3.4). The ratings and comments did not differ significantly by Pilot status. Students in the Pilot Curriculum indicated that they were generally glad that they had chosen the Pilot Curriculum. The specific criticisms of advising included complaints about poorly informed advisors (especially faculty advisors), advisors who did not provide sufficient direction, and turnover of advisors (e.g. due to leaves). Among the many additional comments and suggestions, the largest categories were requests for fewer requirements (especially requests for fewer distribution requirements from non-science majors), complaints about faculty who were not interested in teaching or accessible to students, and dislike of science courses (including complaints that courses were too big and professors were uninterested, and objections to being in science classes with premeds; complaints about science courses may have been increased because this questionnaire began with the Science Survey; see Section 4 below).

Table 3.3 Students' Overall Evaluations of their Undergraduate Education and Advising[a]

How would you **evaluate your entire educational experience** at Penn?
Mean rating: 3.4 (fall, 2003) and 3.5 (fall, 2004)
(between 3 = good and 4 = excellent)
Overall, how satisfied have you been with your undergraduate education?
Mean rating: 4.3 (spring, 2004)
(between 4 = generally satisfied and 5 = very satisfied)

Overall, how would you **evaluate the quality of academic advising** you received in your first two years at Penn?
Mean rating: 2.2 (fall, 2003) (between 2 = fair and 3 = good)
How satisfied were you with academic advising before you declared a major?
Mean rating: 3.0 (ambivalent) (spring, 2004) and 2.9 (fall, 2004)

For Pilot students only
Are you **glad that you chose the Pilot Curriculum,** rather than the Regular Curriculum?
Mean rating: 3.8 (between 3 = ambivalent and 4 = generally yes)

[a] No significant differences by Pilot status were observed. For all of the rating scales in the tables, higher values indicate better ratings, although some of the response options appeared in reverse order in some of the questionnaires.

Table 3.4. Summary of Comments Concerning Penn Education [a]

Opinion	Number
Overall Positive concerning Penn Experience	21
Overall Negative concerning Penn Experience	5
Wanted Better Advising	32
Had Good Advising	3
Should Be Fewer Requirements	10
Faculty Not Interested in Teaching or Accessible to Students	8
Disliked Science Courses	11
Total Number of Students Who Wrote Comments[b]	106

[a] This table shows the number of seniors who mentioned each specified opinion in response to a final open-ended question, Fall, 2003. The 106 who wrote at least one comment constituted 37% of the 288 respondents to this survey.
[b] The total is not equal to the sum of the numbers in specific categories because some students wrote comments on multiple topics and some students wrote comments on other topics not included in this table.

Seniors gave relatively high ratings for the contribution of their Penn education to a variety of general intellectual abilities, with lower ratings for the contribution of their Penn education to more specific types of learning, especially for science, quantitative skills, literature and the arts (Tables 3.5 and 3.6). Two items showed significant differences by Pilot status in a single survey each, but these differences were not replicated in the other surveys. Also, taking into account all three surveys, only 6% (2/34) of the items showed differences with a $p <= .05$, which is what would be expected by chance. Thus, these results suggest no significant difference by Pilot status in these various types of learning.

Table 3.5 Contribution of Undergraduate Education to Various Abilities and Knowledge -- Fall 2003 and 2004[a]

To what extent has your experience at Penn contributed to your knowledge, skills, and personal development in the following areas?

(1= Very little 2= Some 3= Quite a bit 4= Very much)

Means		
2003	2004	
3.4[b]	3.4	Ability to learn on your own, pursue ideas, and find information you need
3.2	3.4	Thinking critically and analytically
3.1	3.3	Ability to integrate diverse information and ideas from multiple sources
3.1	3.3[c]	Acquiring a broad general education
3.0	3.2	Developing an understanding of people, societies and/or governments
2.8	3.0	Writing clearly and effectively
NA[d]	3.0	Ability to formulate original ideas and solutions
2.5	2.6	Broadening your acquaintance with and enjoyment of literature
NA	2.5	Using quantitative tools (e.g. statistics, graphs)
2.3	2.4	Developing an understanding of art, music and/or drama
2.3	2.5	Understanding the process of science and experimentation
2.1	2.4	Understanding new scientific and technical developments

[a] No significant differences by Pilot status were observed for most items; the single exceptions in each year are indicated below.

[b] Significantly different for Pilot (3.5), Applicant Non-Pilot (3.1), and Non-Applicant Non-Pilot (3.3) ($p = .03$ overall and $p = .07$ for Pilot vs. Applicant Non-Pilot comparison) (fall, 2003)

[c] Significantly different for Pilot (3.2), Applicant Non-Pilot (3.2), and Non-Applicant Non-Pilot (3.5) ($p = .006$ overall, but not significant ($p = .36$) for Pilot vs. Applicant Non-Pilot comparison) (fall, 2004)

[d] NA = not asked in 2003

Table 3.6 Change in Ability since Entering College -- Spring, 2004[a]

Please indicate how your ability in each area has changed since you first entered college.
(1 = weaker now, 2 = no change, 3 = stronger now, 4 = much stronger now)

Means	
3.4	Acquire new skills and knowledge
3.2	Think analytically and logically
3.2	Synthesize/integrate ideas/information
3.2	Knowledge in social sciences
3.1	Write effectively
3.1	Place current problems in historical cultural/philosophical perspective
3.1	Knowledge in humanities
3.0	Formulate original ideas/solutions
2.9	Communicate orally
2.7	Use quantitative tools
2.6	Understand process of science
2.5	Knowledge in natural sciences

[a] No significant differences by Pilot status were observed.

One reason why seniors, on average, reported less gain in specific types of learning than in general intellectual abilities is that students often reported relatively little learning outside the sector of their major (Table 3.7). Specifically, science majors reported less learning than non-science majors in the humanities, and non-science majors reported substantially less learning than science majors in both the natural sciences and quantitative skills. Indeed, many of the non-science majors reported "very little" contribution of their Penn education to understanding science, or "no change" or "weaker now" in their science knowledge and understanding and their ability to use quantitative tools.

Although the Pilot Curriculum would be expected to particularly affect learning in areas outside the major, we found no difference by Pilot status in mean scores for science or quantitative skills learning among non-science majors, and no difference by Pilot status in mean scores for humanities learning among science majors. Since some Pilot non-science majors take very few science or math courses (Section 1), we tested for differences by Pilot status in the proportion of non-science majors who reported little or no science and quantitative skills learning. We found no difference by Pilot status in the proportion of non-science majors who reported either "very little" contribution of their Penn education to their science or quantitative skills learning or "no change" or "weaker now" for science or quantitative skills knowledge and understanding.

These results provide no support for the optimistic hope that the Pilot Curriculum would improve science education for non-science majors or for the pessimistic concern that the reduced number of required science courses would significantly reduce science learning. This conclusion is further supported by our tests of scientific and quantitative literacy described in Section 4 below. Our evidence indicates substantial problems in science education for non-science majors who are not premeds in both the Regular Curriculum and the Pilot Curriculum. This outcome is presumably related to the negative student reaction to many required courses, which is described in the following subsection.

Table 3.7 Self-reported Gains by Science/Non Science Major Status[a]

Contribution of Education (fall 2003, 2004)	Science Major	Non-science Major
Understand scientific/technical developments[b]		
2003	2.9	1.8 (43% very little)
2004	3.1	2.0 (33% very little)
Understand process of science[b]		
2003	2.9	1.9 (34% very little)
2004	3.3	2.1 (28% very little)
Using quantitative tools (2004)	2.8	2.3 (20% very little)
Integrate diverse information/ideas (2004)	3.2	3.4
Formulate original ideas and solutions (2004)	2.9	3.1
Understand people, societies, governments		
2003	2.7	3.2
2004	2.7	3.5
Writing clearly, effectively		
2003	2.6	3.0
2004	2.6	3.2
Acquaintance with/enjoyment of literature		
2003	2.2 (22% very little)	2.7
2004	2.2 (25% very little)	2.8
Understanding art, music, drama (2004)	2.0 (37% very little)	2.6
Change in Ability (spring, 2004)	Science Major	Non-science Major
Knowledge in natural sciences	3.3	2.2 (68% no change or weaker now)
Understand process of science	3.5	2.4 (61% no change or weaker now)
Use quantitative tools	3.0	2.6 (43% no change or weaker now)
Historical cultural/philosophical perspective	2.9	3.2
Knowledge in humanities	2.9	3.2

[a] This table includes all items from Tables 3.5 or 3.6 which showed significant differences in mean scores between science and non-science majors ($p <= .05$; shown only for years in which difference was significant). Percent "very little" is given if > = 20% and percent "no change or weaker now" is given if > = 40%. See Tables 3.5 and 3.6 for definitions of scales. Science majors were defined as students who had at least one major in the natural sciences or math (Biology, Biochemistry, Biological Basis of Behavior, Biophysics, Chemistry, Cognitive Science, Environmental Studies, Geology, Mathematics, Physics and Astronomy, Psychology) or were enrolled in Engineering as well as the College.

[b] For the fall surveys, we also analyzed non-science majors who took 5 or fewer science and math courses (thus excluding premeds) and found slightly lower scores for science and quantitative learning (1.6 and 2.0 for understanding scientific/technical developments, 1.8 and 2.0 for understanding the process of science, and 2.2 for quantitative).

Courses Taken Only Because Required

To investigate student responses to required courses we asked seniors to report how many required courses in various categories they had taken "only because they were required and not because you were interested in them". Students who reported such courses were asked to rate the amount learned in these courses.

Table 3.8 shows that over three-quarters of students reported taking two or more General Requirement courses only because they were required, and most students who reported taking course(s) only because required reported learning relatively little in these courses. Similarly, for the Quantitative Data Analysis Requirement and the Writing Requirement, more than half the students report taking a course only because required, and most of these students reported learning relatively little from this course. These problems appear to be less severe for other categories of requirements, because relatively fewer students reported taking course(s) only because they were required (especially for preprofessional requirements), and/or students generally reported learning more in courses taken only because they were required (especially for preprofessional and major requirements).

For each category of requirements, there was no significant difference by Pilot status in either the number of courses students reported taking only because required or the rating of amount learned. This is particularly striking for the General Requirement category, since Pilot students have fewer required courses in this category (4 vs. 10, although the apparent difference in number of General Requirement courses is reduced by the ability of students in the Regular Curriculum to use AP credits and/or double count courses with the major in some cases, whereas Pilot students can only be exempted from at most one Pilot general requirement course).

The problem of self-reported General Requirement and Quantitative Data Analysis courses taken only because required was more serious for non-science majors than for science majors. Specifically, science majors reported significantly fewer General Requirement courses taken only because required (1.9 vs. 2.6 in 2003 and 2.2 vs. 2.8 in 2004). Science majors also were significantly less likely to report taking a Quantitative Data Analysis Requirement course only because required (24% vs. 71% in 2003 and 46% vs. 69% in 2004). None of the other differences between science majors and non-science majors in number of courses taken only because required or ratings of amount learned was consistent in both samples.

Table 3.8 Percent of Students Who Report Taking Courses Only Because Required and Not Because Interested, and Amount Learned in Such Courses[a]

Type of Course	Number Taken Only Because Required					Amount Learned[b]		
	0	1	2	3	>=4	Quite a Bit	A Little	Not Much
General Requirement[c]	18%	18%	22%	20%	24%	13%	43%	33%
	20%	14%	21%	15%	31%	28%	37%	22%
Quantitative	47%	49%	4%	1%		17%	41%	41%
	39%	61%				29%	41%	30%
Writing	40%	57%	3%	1%		27%	34%	38%
	21%	72%	7%			33%	33%	33%
Language	58%	13%	15%	8%	8%	24%	36%	31%
	51%	17%	16%	6%	11%	37%	45%	14%
Major	38%	14%	20%	10%	19%	40%	33%	18%
	23%	18%	20%	11%	29%	51%	28%	8%
Preprofessional	81%	2%	4%	6%	8%	43%	37%	11%

[a] Data for spring 2004 are shown in the first line for each category and data for fall 2004 are shown in the second line (except preprofessional which was not asked in the fall). None of the responses differed significantly by Pilot status.

[b] Amount learned distribution is given for students who reported at least one course taken only because required. The percent who reported "varied for different courses" is not shown (range: 1%-13%).

[c] General Requirement courses were either in the Regular Curriculum or the Pilot Curriculum (for Pilot students).

A different perspective on amount learned in required courses is provided by an analysis of the amount that students reported learning on Course Evaluation Forms which were completed at the end of General Requirement courses (in the Regular Curriculum, fall and spring semesters, 2001-2 and 2002-3). Although students who took these courses to fulfill the General Requirement reported significantly less learning (mean = 2.33) than students who took these courses for their major (2.53) or as an elective (2.47), in each case the mean rating of amount learned was between 2 = good and 3 = very good. Generally similar results were observed within specific sectors. Mean ratings for amount learned by students taking courses to fulfill the General Requirement did not differ significantly by sector and did not suggest lower learning in the biological and physical sciences compared to the humanities, as shown in the following listing:

2.15 -- Formal Reasoning and Analysis
2.23 -- Arts and Letters
2.33 -- Physical World
2.37 -- History and Tradition
2.43 -- Society
2.49 -- Living World

These Course Evaluation Form data suggest more learning in General Requirement courses than was suggested by our survey data reported above. We propose two reasons why our survey data may underestimate the amount learned in required courses. First, students who reported taking a course only because it was required and not because they were interested may have been inclined to underestimate the amount learned in the context of the survey questions on this topic. Second, many students take a course not only to fulfill a requirement, but also because they are interested, and these students probably learn more from the required courses. It seems likely that students who take a course only to fulfill a requirement learn less because they devote less effort and attention to these courses and because they seek out easier courses which require less work and less learning.

There appears to be substantial variation in the amount learned in different individual courses taken by students to fulfill the General Requirement, as indicated by the range of ratings for mean amount learned, from a low of 1.25 (between 1 = fair and 2 = good) to a high of 3.18 (between 3 = very good and 4 = excellent). This suggests that some current General Requirement courses may be quite effective in promoting general education, whereas others appear to be much less effective.

In summary, students' self-reports indicate very little or no effect of the Pilot Curriculum on various types of learning, satisfaction with the student's educational experience, and participation in various educational activities, although the requirement for a research experience has the expected effect of increasing participation in research. Students' self-reports also indicate that a substantial number of courses are taken only because required, with relatively little self-reported learning in many cases. These problems were observed with equal frequency and severity for students in the Regular Curriculum and students in the Pilot Curriculum.

4. Scientific and Quantitative Literacy, and Interest in Science

To evaluate the contributions of the Pilot Curriculum and the Regular Curriculum to scientific and quantitative literacy, we developed and validated a Science Survey. This survey includes multiple choice items that assess scientific reasoning, and knowledge of important concepts, facts and terminology, primarily in biology, chemistry, physics, environmental sciences, and math. A 24-item paper and pencil version of the Science Survey was administered to the entering freshman class during Freshman Orientation in September, 2001. Early in the fall semesters of 2003 and 2004, a 22-item Web-based version of the survey was administered to the samples of seniors. For comparability, we give the proportion of correct answers for the 22 scientific and quantitative literacy items which were included in the Science Survey for both freshmen and seniors. The surveys for seniors included additional items to assess interest in science (self-rated interest in science and how often the student got science information from various non-course sources).

We received usable surveys from approximately 83% of the entering freshmen (89% of Pilot students vs. 82% of non-Pilot students). Response rates for seniors in the fall of 2003 and 2004 were 67% and 53% respectively. For the seniors, we were able to compare respondents with non-respondents and found several significant differences. Respondents were more likely to be science majors, and in 2003, but not 2004, had earned more CU's, had more total CU's, and had higher GPAs. Thus, our data probably overestimate the scientific and quantitative literacy of seniors in the College.

For the freshmen, Pilot students answered more of the scientific and quantitative literacy items, resulting in more correct answers for Pilot students (Table 4.1). It should be noted that the difference in percent correct was small, but was statistically significant because of the very large sample size. Furthermore, the greater number of questions answered by Pilot students may have resulted from increased motivation due to testing in the smaller Dean's session specifically for Pilot students vs. the much larger Dean's sessions for non-Pilot students. Results from our samples of seniors suggest that scientific and quantitative literacy may not have differed by Pilot status for the incoming freshmen. Specifically, seniors in the Pilot Curriculum, seniors who had applied for the Pilot Curriculum but were not chosen, and non-applicant non-Pilot seniors did not differ significantly in SAT math and verbal scores or number of AP or college-level science and math courses taken before coming to Penn.

Among seniors, the proportion correct for the scientific and quantitative literacy items did not differ significantly by Pilot status (Table 4.1). In addition, in both samples of seniors, there was no significant difference by Pilot status in the proportion of students who had low scientific and quantitative literacy scores (< 45% correct). For a subset of 106 students, we had both freshmen and senior scientific and quantitative literacy scores. For these students there were no differences by Pilot status in change in scientific and quantitative literacy scores. All of these results suggest that there was no difference between the Pilot Curriculum and the Regular Curriculum in effects on scientific and quantitative literacy.

Table 4.1. Scientific and Quantitative Literacy

	Percent Correct					
Sample	Pilot	Applicant Non-Pilot	Non-Applic. Non-Pilot	Science Majors	Non-Science Majors	Total
Freshmen						
Fall, 2001[a]	57%	---- 55%[b] ----		NA[c]	NA	56%
N	179	1086				1265
Seniors						
Fall, 2003[d]	63%	56%	60%	67%	58%	61%
N	123	32	130	95	190	285
Fall, 2004[d]	63%	61%	58%	68%	56%	60%
N	95	86	102	95	188	283

[a] Differed significantly by Pilot status (p=.05), see discussion above.
[b] Applicant and non-applicant non-Pilot students have been combined because they could not be reliably distinguished in this survey.
[c] NA = not applicable
[d] No significant difference by Pilot status, but significant difference by science major status, p<= .001.

The pattern of results shown in Table 4.1 suggests the possibility that a College education contributes relatively little to scientific and quantitative literacy for non-science majors. Specifically, the percentage of items correct on the Science Survey was very similar for freshmen (56%) and for seniors who were non-science majors (58% in 2003, 56% in 2004). For the subset of 106 students who completed the Science Survey in both freshman and senior years, the increase in percentage correct was 3.9% for non-science majors, compared to 12.3% for science majors. This increase in science and quantitative literacy was significant for science majors ($p < .001$) and nearly significant for non-science majors ($p = .07$). The difference between these two groups was also significant ($p = .03$). As discussed in Section 3, self-report data also suggest relatively weak science and quantitative learning by non-science majors.

For seniors in 2003 and in 2004, there was no significant difference by Pilot status in several measures of science interest, including scores on the Science Interest scale, average number of science and math courses taken at Penn, or whether or not they had a natural science or math major (based on both self-report data and analysis of student records, see Section 1). Evidence presented in Section 3 suggests that many non-science majors are not interested in at least some of the natural science and quantitative data analysis courses they are required to take, and this appears to apply equally to both Pilot and non-Pilot students.

In summary, our results indicate that seniors in the Pilot Curriculum did not differ from other seniors in terms of scientific and quantitative literacy, self-reported science learning, or interest in science. Evidence presented in this section and Section 3 suggests relatively weak natural science and quantitative skills learning for non-science majors in both the Regular Curriculum and the Pilot Curriculum.

5. Faculty Evaluations

Interviews with first semester faculty

In spring 2001, following the first semester of the Pilot, Committee members conducted telephone or face to face interviews with each faculty member teaching a Pilot course. The Committee thought it important to interview individuals rather than teams to ensure that issues of coordination and integration could be discussed candidly. Interviewers worked from the same set of questions, but allowed discussions to flow naturally. The questions were as follows:

1. Overall, what were the successes and problems you encountered in teaching your Pilot Curriculum course?
2. How did you feel about the team teaching in this course? What were the advantages and disadvantages?
3. In what way did you collaborate with your colleagues, as opposed to simply dividing the course into independent units?
4. What were the advantages and disadvantages of the interdisciplinary approach for this course?
5. How did the amount of preparation time for this course compare with other first-time courses you have taught?
6. Did the experience of teaching this course differ from what you expected? How?
7. Do you think that the students in your Pilot course were different from other students you've taught at this level? If so, how?
8. Overall, how effective do you think the course was in achieving your goals?
9. Do you plan to teach this course again? If not, why not?
10. What advice would you give to someone who is planning to teach a Pilot course?

Optional:

1. What was it that attracted you to teach a Pilot Curriculum course?
2. Did you use Blackboard or a listserv? If yes, was it useful?

Faculty consistently reported enthusiasm for team teaching (all but one of the courses in the first semester were team-taught), and a number of them commented that it was the most satisfying intellectual experience related to undergraduate education that they had ever had. Several observed that team teaching far from reducing the amount of time they spent preparing for class increased it significantly. Most of the teams reported spending time each week coordinating class presentations and discussions in addition to the efforts they had made during the previous summer to prepare a syllabus that integrated their various perspectives.

Forums with faculty

Following these interviews, the Committee organized a forum attended by many of the faculty who had taught in the first academic year (fall and spring), faculty who were preparing new courses for the second year of the Pilot, and members of the Evaluation Committee. The session was taped. Discussion centered on the challenges of team teaching and the value of an interdisciplinary approach in courses intended to serve as vehicles for general education for first and second year students. Faculty who had taught or who were teaching these courses generally

expressed high satisfaction with the experience. They stressed the importance of good regular communication with one another and a genuine interest in one another's material. The team teaching and the interdisciplinarity usually meant that faculty had to back away from the thorough coverage of content to which they were accustomed in their other teaching. They endeavored instead to help students understand alternative approaches to a given topic or question, and how those approaches relate to one another.

Feedback from a number of students indicated that they did not always understand what the courses expected of them, and faculty at the forum suggested that they may need to make a special effort at various steps along the way to explicate just what they are doing with the material and why they are doing it. One Committee member, noting that team teaching in the long run could be sustained only if enrollments became much larger than they were in the first year of the Pilot, wondered which model of interdisciplinary general education was preferable: large classes with team teaching or smaller classes taught by individuals. The response from faculty experienced teaching Pilot courses was that they wanted to have it both ways: smaller, team-taught classes with, however, two-person teams rather than three-person teams. In sum, the model employed in the Pilot classes so far was highly regarded by the faculty teaching them, even as they recognized that something would have to give if the General Requirement were to be built around this model for all students in the College.

A similar forum held in the spring of the second year yielded a markedly different tone. The conversation focused more on some of the feedback from students that by now had been circulating, to the effect that they found integration of the multiple perspectives offered through team teaching difficult and frustrating. These reports of student sentiment elicited some bemoaning of the lack of maturity of some first and second year students, of the common fixation on grades, and of the reluctance of some to allow themselves to be engaged by the open-ended flow of ideas that many of these courses aimed to inspire and their preference to be told exactly what specific material the professors wanted them to learn.

Debriefings with faculty

In the second year of the Pilot, administrative directors from the College began holding regular post-mortem meetings with faculty teaching Pilot courses (collectively in the case of team-taught courses) to review syllabi, learn how satisfied faculty were with the course and the various assignments, learn how satisfied they were with the quality of students' work in the class (homework assignments, class discussions, exams or term papers) and to ask if there were changes they would like to make when offering the course again, and to read together the students evaluations. The purpose of these meetings was to help faculty take stock of the course and to offer resources for ongoing improvement.

Through the exercise of reading the evaluations, they discovered in perhaps every case a complexity in students' responses to these courses that is not reflected in the standard course evaluations. Although the standard evaluations of overall course and instructor quality were in many instances lower than the school averages and were often lower than the evaluations these individual faculty themselves were used to seeing for their other courses—this was especially so in the case of team-teaching—the comments from the supplemental evaluation forms told a more interesting story. The supplemental forms elicited more comments, and more thoughtful

comments, than is typical on the standard evaluations. In every course, there were a good number of students who were very enthusiastic about the course and the quality of the instructor(s) and also, in most courses, a number who were critical. For what it is worth, the positive comments usually outnumbered the negative ones, even when the total responses on the Likert scale associated with that question were evenly split between positive and negative. For whatever reason, enthusiastic students were more willing to express their enthusiasm with commentary than were students who were critical.

We have not been able to see whether a similar pattern is evident in the supplemental evaluations of a set of courses from the regular General Requirement, because the comments have not been collated.

6. Student Focus Groups

The Pilot Evaluation Committee has held 10 focus groups to gain insights into experiences of students who are enrolled in the Pilot Curriculum and in the Regular Curriculum. Three focus groups were held in 2000-2001, four in 2001-2002, and three in 2002-2003, with each group consisting of 5 to 12 students. All focus groups were videotaped and a graduate student observer prepared written summaries of the discussions.

The focus groups of Pilot students in the first two years solicited students' views on features of the Pilot Curriculum that had led them to apply for the program, the quality of Pilot Curriculum courses, use of electives, academic plan, research requirement, and advising. The focus groups in the third year emphasized students' experiences with advising and the research requirement. The focus groups with non-Pilot students similarly sought information about students' views on quality and choice of courses, the possible institution of an Academic Plan, research requirement, and advising.

The differences in the two curricula were mainly reflected in the students' views of the choice of courses that they were required to take. Pilot students complained about the limited number of available required Pilot courses in their first two years at Penn, and Regular Curriculum students expressed some frustration with required, mainly science, Regular Curriculum courses they had to take. In general, Pilot students appreciated the smaller number of requirements and Regular Curriculum students, particularly those who had applied for the Pilot Curriculum but were not chosen and those with a double major, expressed frustration with the number of Regular Curriculum requirements. Both Pilot Curriculum and Regular Curriculum students told us that required courses they had taken influenced their subsequent choice of courses. Experiences with advising ranged from very helpful to not helpful at all among both Pilot Curriculum and Regular Curriculum students, although overall Pilot students appeared to have been somewhat more satisfied with their advisors. Pilot students expressed frustration about the lack of information concerning the research requirement and, when asked, Regular Curriculum students were apprehensive about instituting a research requirement for all Penn students.

Pilot Students (6 focus groups)

The principal reasons for applying for the Pilot Curriculum were that it had fewer requirements and thus provided greater freedom to choose electives than the Regular Curriculum. These aspects seemed particularly attractive to students interested in a double major. Some students were also attracted to the Pilot Curriculum by the interdisciplinary nature of Pilot courses.

Most students were content in having chosen the Pilot Curriculum and many, but not all, would recommend it to others. At the same time, students were critical of the limited choice of Pilot Curriculum courses in their first two years at Penn and the quality of many of the courses offered. Courses students had taken shaped their views about course quality and not all views were negative. Most frequent complaints centered on too much material being covered in a single semester and a lack of coherence in courses with multiple instructors. Courses that students perceived to be better integrated and in which team teaching worked smoothly received more favorable reviews. In some cases Pilot Curriculum courses had influenced students' subsequent choice of courses by encouraging further study in a given area or by discouraging

students from taking additional courses in a subject matter. Recommendations for changes included increased variety in course offerings, improvement in the quality of instruction (if courses were to be team taught, two rather than three professors was preferable), and smaller classes.

In the first two years, students expressed frustration about the lack of information regarding the research requirement. By the spring of their junior year, none of the Pilot students had engaged in research experiences that would fulfill the Pilot Curriculum research requirement. However, many reported having conducted research in a variety of other settings: summer internships, an optional research paper for a class, an independent study, etc. A Vagelos scholar had conducted research in a lab, and others noted that in their view a research requirement for a major would overlap with the Pilot Curriculum research requirement.

Students gave mixed opinions about the required Academic Plan. Because many students must prepare a plan for a major, some students found the requirement redundant while others noted that the exercise was beneficial in helping them think through what they wanted to do and what was feasible. None of the students reported much give and take with their advisors in writing their Academic Plans. Nevertheless, many students who participated in a focus group in their junior year believed that writing the plan had been helpful, and most students reported that they were following their plans.

The reports on advising ranged from very helpful to not helpful at all. Most students reported that they had sought information on the following topics: course selection, clarification of requirements, identification of faculty in various departments, exploring and selecting a major, and learning about academic options outside the major. Pilot students also reported that their advisors were unable to answer questions about the criteria or expectations for the research requirement.

Pilot Curriculum applicants currently enrolled in the Regular Curriculum (2 groups)

During the freshman year, students in this group felt that they had more choice in course offerings than the Pilot students, who had to choose from a limited number of available Pilot Curriculum courses. By the sophomore year, however, these views had changed. The Regular Curriculum students now felt that their freedom to choose was limited, they could not find interesting courses in all required areas, and some students complained about the quality of science courses for non-majors. Students felt that these science courses were of a lesser quality than required social science courses, which are taken by both majors and non-majors.

As was the case with Pilot students, required courses students had taken had influenced their subsequent choice of courses by both encouraging and discouraging further study in a given area.

Several students stated that they were planning to conduct research within their majors as a senior thesis, but all felt that a research requirement for all Penn students would not be a good idea. They stated that students who have no interest in engaging in research should not be required to do so. Students recommended some changes in the Regular Curriculum, such as allowing upper level courses to count for Regular Curriculum requirements.

Non-applicants enrolled in the Regular Curriculum (2 groups)

These focus groups were held with sophomores and juniors in 2001-2002 and 2002-2003. Students felt that they had adequate choice of classes, although those who were double majoring expressed some frustration in their ability to take electives. Students also expressed the view that the Regular Curriculum had provided a beneficial structure during their freshman year and that required courses gave them an opportunity to explore multiple fields. Students also noted that Regular Curriculum required courses had influenced their subsequent choice of courses, including a choice of a minor. These students expressed mixed views about instituting a research requirement for all Penn students. Students recommended several changes in the Regular Curriculum, including lowering the number of required courses, providing more flexibility in choosing courses among sectors, and allowing advanced placement courses to count towards the General Requirement.

As was the case with the Pilot students, students enrolled in the Regular Curriculum had mixed views of the advising process and these experiences were similar to those of the Pilot students. On the whole, however, a larger proportion of Pilot students were somewhat more positive about the advising process than non-Pilot students. At the same time, there was not much difference in the number of times Pilot Curriculum and Regular Curriculum students met with their advisors, or topics that were discussed, except that none of the Regular Curriculum students said that they had discussed academic options outside their major with their advisors.

7. Pre-Major Advising in the Pilot Curriculum

The advising of Pilot students differs from that of students in the Regular Curriculum during the students' freshman and sophomore years. After the sophomore year there are no systematic differences in the academic advising of Pilot and non-Pilot students. The extent to which advising Pilot freshmen differs from advising other freshmen is related to the structure of the Pilot Curriculum. First, Pilot students have a limited number of requirements, a greater number of electives, and thus less structure in the program in their freshman and sophomore years than students enrolled in the Regular Curriculum. These factors affect advising of Pilot students in both freshman and sophomore years along with the additional feature of the required Academic Plan that Pilot students must submit and discuss with their advisor by the end of the second semester of their sophomore year (see Section 8 below). Sophomores in the Regular Curriculum continue with their freshman advisors, but they are not required to meet with their advisors or to write an Academic Plan. Conversations that may occur are not as structured as they are for Pilot students, for whom the Academic Plan dictates a certain purpose and importance to their meetings with their advisors.

All students in the Pilot Curriculum submit their Academic Plans in writing by the end of the second semester of the sophomore year. Advisors must sign off on these plans and forward them to the College Office so they can be made available for analytical purposes. Pilot students cannot register for classes in their junior year until the plan has been submitted and approved, a requirement that ensures that all Pilot students submit an Academic Plan.

The Evaluation Committee met with Pilot student advisors during the spring of the first two years of the Pilot Curriculum (2001 and 2002) to solicit their views of the advising process.

For the first meeting, the Committee formulated four questions in advance:

> Did the advisors experience anything different about advising students in the Pilot Curriculum compared with previous experiences advising students in the Regular Curriculum?
>
> To what extent did they find students in the Pilot thinking ahead about their academic programs?
>
> Did students in the Pilot seem more adventuresome in their thinking about their academic programs?
>
> Were students in the Pilot Curriculum asking different kinds of questions from those asked by students in the Regular Curriculum?

The general consensus among both faculty and assistant deans serving as academic advisors was that advising students in the Pilot was more satisfying but also more challenging than advising students in the Regular Curriculum. Questions students asked tended to be more about how they might follow up on interests raised in their Pilot classes than about what courses to take to satisfy a certain sector requirement. In general, discussions with advisees were more focused on students' academic interests and goals and less on structural matters pertaining to requirements.

Advisors thus found themselves engaged in more interesting conversations with advisees about academic content, but they often felt unprepared to respond to questions about academic interests with helpful, practical recommendations. One strategy some adopted was to refer students to faculty whom they knew who worked in the areas of their advisees' interests or, failing that, to the undergraduate chair in the relevant department. Although it was somewhat disconcerting, especially for faculty serving as advisors, to be unable to provide helpful advice in every instance, they felt that making referrals in this way after a conversation about students' interests was preferable to what they remembered from advising sessions with students in the Regular Curriculum. Those conversations typically revolved around helping students decide which courses to take in order to fulfill various sector requirements.

In addition, advisors passed on to the Committee some of the same concerns from students that the Committee heard directly from students themselves, namely that there were not many courses from which to choose and that students often had a difficult time integrating material and perspectives presented in team-taught courses, especially those involving three-person teams.

Despite the enthusiasm of Pilot advisors for the new system, students were much less favorable. The Committee obtained students' views on advising in the focus groups (Section 6) and from the senior surveys (Section 3). On average, students expressed considerable dissatisfaction with advising in their first two years at Penn and this was true for both Pilot and non-Pilot students.

In summary, Pilot student advisors expressed generally positive views of their experience and indicated that advising Pilot students was more satisfying and challenging than advising non-Pilot students. These advisors believed that they spent more time discussing students' academic goals and interests and less time on specific requirements with Pilot than non-Pilot students. In contrast, all students regardless of Pilot status expressed substantial dissatisfaction with advising in their first two years at Penn.

8. Assessment of Academic Plans

Students in the Pilot Curriculum are required to write a comprehensive academic plan and discuss it with their advisors by the end of the students' sophomore year. Students are told that the Academic Plan should include the following elements: brief personal narrative, overview of one's program, choice of major, research project, and free electives.

To evaluate this requirement, the Evaluation Committee met with Pilot advisors in the spring of 2002 after Pilot students in the first class had written and submitted their Academic Plans. The Committee reviewed academic plans submitted by Pilot students in the spring of 2002 and 2004. In 2002 each Committee member read ten randomly chosen plans from among those submitted, and in 2004 two Committee members reviewed 20 randomly chosen plans each. These reviews were discussed at Committee meetings. In addition, the Committee surveyed Pilot Curriculum advisors in the fall of 2004 to solicit their views on the value of the academic plan for students, changes in the quality of the plans over time, and whether the plan should be required of all Penn undergraduates. Students' views on the Academic Plan were obtained in the focus group discussions (see Section 6) and from the education survey administered in the fall of 2004 to seniors (Section 3).

Several of the eleven advisors who attended the meeting in the spring of 2002 had required advisees to rewrite their academic plans after a first conversation with students about them. A common observation advisors made about the plans was that students tended to devote more attention to the Pilot courses they had taken than to what they would do with the elective portion of their studies. (It was observed that this tendency may have been created unwittingly by some of the sample plans that were made available to students.) Despite this, advisors found the exercise to be constructive. Several were adamant that the plans not be filed away but that they be made available to major advisors, not as firm commitments to which students would be held but rather as starting points for further conversations in which students' plans for the major, and specifically for research, would become more refined.

Twelve Pilot student advisors responded to the fall 2004 survey. Ten of the 12 respondents believed that the writing of the Academic Plan helped students make better use of educational opportunities at Penn. Many felt that writing the plan forced students to give more thought to what they had done and where they were going, and the requirement itself helped guide the conversations they had with their students. Similarly 10 of the 12 Pilot advisors responded yes when asked "would you recommend that all students be required to write an academic plan?" There was also a general consensus that the quality of the academic plans had not changed over time. The quality reflects the amount of work a student is willing to put into the writing and this variability appears to stay fairly constant from year to year.

The two reviews of the academic plans by members of the Evaluation Committee revealed that most of these plans were about one to two pages long, single spaced, and that the plans varied widely in tone and content. The consensus of the Committee was that while most of the plans were quite thoughtful, they generally did not say much about what had been regarded by the faculty as the most important element, namely, the intentions and rationale for taking elective courses. Furthermore, they tended to be more retrospective than prospective. A considerable amount of space was devoted to what courses they had taken, why they had chosen those

courses, and what they had learned from them. Secondarily, they often talked at some length about the intellectual journey that led to their choice of a major, and how that choice related to their career plans, or lack thereof. Some students had a clear idea of how they intended to satisfy the research requirement, while others were quite vague or uncertain. In accordance with the views of the Pilot advisors, the Committee further felt that there had not been substantial changes in the overall quality of the plans over time.

In the fall 2004 education survey of seniors, two questions were asked of Pilot students regarding their experience with the Academic Plan. The first question asked "Did your academic plan help you make good course choices?" Fifty-one percent of the 106 Pilot students responded no, 35% answered somewhat, and 11% said yes. The second question asked "Did you accomplish the goals you presented in your Academic Plan?" Fifty-five percent of the 106 students responded yes, 33% answered somewhat, and 12% said no.

Student expressed mixed opinion about the Academic Plan in the focus groups, although many students who participated in the focus groups in their junior year believed that writing the Academic Plan had been helpful and most said they were following their plans.

In summary, the vast majority of Pilot student advisors who met with the Committee or responded to the fall 2004 survey believed that writing an Academic Plan was an important exercise and should be required of all students at Penn. These advisors felt that the plan helped students focus on available educational opportunities at Penn and it helped guide the discussions between the advisor and the student. The views of the Pilot students on the other hand were more mixed. Just over half (51%) of the Pilot students felt that the Plan had **not** helped them make better course choices. At the same time, a majority of the students said that they had accomplished the goals they laid out in their Academic Plans.

9. Research Requirement

The Pilot Curriculum is designed to offer students significant opportunities for individual research, scholarship and/or creative projects, and all Pilot students must engage in some form of research prior to graduation. Research is optional for many students enrolled in the Regular Curriculum, although it is required in some majors. Pilot students can fulfill the research requirement in a number of ways--by taking an upper level research seminar or an independent study, writing a senior thesis, or conducting research in a laboratory. Students have been advised to consult with their major advisor to discuss ideas, available research opportunities, and to identify faculty who can offer guidance in the specific area of research. The College expects that most Pilot students will fulfill the research requirement in the context of their major during the students' senior year. Research projects are evaluated and approved by the student's major department unless the student's research project is in an area unrelated to the major, in which case the department related to the area of research will evaluate and approve the student's work.

In spring 2002, the Committee on Undergraduate Education (CUE) solicited information about the nature of research experiences that are or could be offered for undergraduate students in the College. Not surprisingly, responses to this inquiry suggest that there is considerable variation in departmental research requirements and available research opportunities that are related to disciplinary considerations and the number of majors. All departments provide some opportunities for independent research, but not all departments require that students engage in independent research as a condition for graduation. Most departments in humanities and social sciences expect students to take upper level research seminars, independent studies with a research component, or a capstone course, or students have the option of writing a senior thesis (in some departments this option is available to all students and in others students must qualify for departmental honors). The rigor of these requirements varies by department. In the science departments, many students gain research experience by working in a lab as a research assistant, a work study student, an independent study student, or a volunteer. In addition, many students gain experience in designing experiments, evaluating research findings, or conducting lab experiments as a part of an upper-level course within the major.

In the fall of 2003, the College surveyed Pilot Curriculum seniors via an email questionnaire to determine whether students were making progress in fulfilling the research requirement. Responses were received from 115 of the 175 Pilot students surveyed. Table 9.1 summarizes results from this survey. Overall, 26% of the respondents were engaged in research in a laboratory or other experiments, often in combination with library and/or other related research. Forty-three percent of the students reported that they were engaged in secondary or survey data analyses, including ethnographic field work, interviews and observations, often in combination with library and other research. In response to the question, "Do you plan to work on this project one semester or more than one semester?", about half of the respondents reported that they planned to work on their projects more than one semester.

Table 9.1 Responses to the College Survey of Pilot Students' Research Experience

Projects by Type of Research and Length	Number
Type of Research (among students reporting only one category)	
Laboratory & other experiments	18
Library research	24
Secondary data analysis	2
Survey study	0
Creative project	2
Other	12
Type of Research (among students reporting multiple categories)	
Library & Creative project	3
Library and Interviews	2
Library & Secondary data analysis	16
Library, Lab & Survey study	1
Library & Lab	1
Library & Other	4
Library & Survey study	4
Library, Secondary data analysis & Other	5
Library, Secondary data analysis & Survey study	4
Library, Secondary data analysis, Survey study & Other	1
Library, Secondary data analysis & Lab/other experiments	3
Lab & Other	1
Lab & Secondary data analysis	6
Secondary data analysis & Other	1
Secondary data analysis & Survey study	1
Secondary data analysis, Survey study & Other	2
Survey study & Other	2
How long are you working on this research:	
One semester	50
More than one semester	59
No Answer	6
	N = 115

Our spring 2004, web-based survey (see Section 3) asked multiple questions concerning research experience of both Pilot and non-Pilot students. As expected, more Pilot students (96%) than non-Pilot students (73% of applicants and 66% of non-applicants) reported doing research. As summarized in the following paragraphs, there were very few differences by Pilot status in the reasons for doing research, types of research, and evaluation of the research experience.

As expected, only Pilot students report that they had done research as a Pilot requirement. Among students who were doing research, there were no differences by Pilot status in the proportions who indicated that they were doing research as a major requirement (54%), an honors requirement (37%), a class requirement (42%), and/or for personal interest (67%), but non-Pilot, non-applicants were more likely to report doing research for "other" reasons (21% vs.

8% for Pilot students and 6% for applicants). There were no differences by Pilot status in the proportion of students who indicated that they were doing research as an independent study (50%), as part of a course (64%), or "other" (21%).

Among students who were doing research, there were no differences by Pilot status in the proportions of students who indicated that they were doing the following types of research:

laboratory research (24%)
interview or questionnaire collection of data (39%)
ethnographic or observational field research (26%)
archival research of original documents (42%)
textual analysis (50%)
statistical analysis of own data (30%)
statistical analysis of data collected by others (26%)
review of previous research (58%)[3]
art, film, video or music project (8%)
"other" (7%).

The average rating for quality of research experience was 1.77 (between 1 = excellent and 2 = good); this rating did not differ significantly by Pilot status. In response to an open-ended question concerning valuable aspects of the research experience, students mentioned especially better understanding of the research process and methods and the relationship with a mentor; the responses were generally similar for Pilot and non-Pilot students.

Only 8% of students who did research reported that it was quite difficult or very difficult to find a research project, and this did not differ by Pilot status. The reasons reported by 39 non-Pilot students for not doing research were as follows:

49% not interested
10% couldn't find a good research opportunity
59% not enough time due to other course requirements
36% not enough time due to nonacademic activities
5% "other".

In summary, as expected, the research requirement in the Pilot Curriculum resulted in a higher proportion of students engaged in research. The self-reported nature and quality of the research experience was similar for Pilot and non-Pilot students.

[3]Review of previous research was almost always reported in conjunction with at least one other activity. Only two Pilot students and one other student reported research that only involved reviewing previous research.

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