

Eventual Majors of Students Who Enrolled in MATH 124 and CHEM 140: A Study of 1992 Entering Freshmen¹

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March, 1999*

REPORT OVERVIEW

MATH 124 and CHEM 140 are heavily subscribed courses that are required for many majors, mainly in science and engineering. The purpose of this study was to determine how many freshmen who entered UW in 1992 enrolled in either course and then did or did not require it for their major. The study also looks at variables that might predict subsequent major choice.

[Sample Sizes](#)

The initial number of freshmen who entered UW in 1992 was 3724. Of these, 1347 enrolled in MATH 124, and 1172 passed the course (0.7 or above). For CHEM 140, 1505 students enrolled and 1431 passed the course.

[Enrollment and Graduation Rates](#)

Students who passed each course had the highest graduation rate, followed by those who did not enroll in the class. Students who withdrew or failed had the lowest graduation rate.

[Entering Data](#)

Students who passed MATH 124 and/or CHEM 140 came into UW with higher average high school GPA's, considerably higher average SAT Math scores, and slightly higher average SAT Verbal scores as compared to those who never passed the course.

[Requirements of the Final Major](#)

For each of the two courses, final majors were classified into those that required the course, those that did not require the course, and those for which the course was an optional requirement. About 25% of students who took each course finished a UW major that required it. Excluding non-graduates, the percentages were 33% and 38% for MATH 124 and CHEM 140, respectively.

[Predictors of Need for the Courses](#)

The strongest predictor for whether MATH 124 or CHEM 140 would be a requirement for the final major was the grade in the class. Of the students for whom MATH 124 was a requirement of the major, 75% received a grade of 3.0 or above. Of the students for which MATH 124 was not a requirement, 75% received a grade of below 3.0. Comparable, but slightly smaller values were found for CHEM 140. SAT

Math scores were also a significant predictor. Students who majored in a field that required either course were much more likely to have scored above 600 than students who did not.

Discussion and Conclusions

Curricula that require MATH 124 and CHEM 140 most often require that they be taken early, thus many students will probably continue to take the courses unnecessarily. SAT Math scores can help students decide whether they will ultimately pursue a major that requires either course. Both courses continue to function as gateway courses for science and engineering majors in that the grade received appears to exert a powerful influence.

METHOD AND PURPOSE

Two University of Washington classes with large annual enrollments are MATH 124, which is the first course in the beginning calculus series, and Chemistry (CHEM) 140 (now renumbered 142) which is required for many science and engineering majors. These two courses are often considered bottle-neck courses because each is required for a number of majors and a prerequisite for a number of other courses and each, if required, needs to be taken early in one's program. Thus, there is a high demand among new freshmen. It is common knowledge that many students take these courses at a time when they think they will be required for their eventual undergraduate major only to discover subsequently that they are not cut out for that particular major by reason of interest, ability, or ambition. Had they known this in advance, odds are that many would not have enrolled in the course. The purpose of this study is to determine how many freshmen who entered UW in 1992, enrolled in MATH 124 and/or in CHEM 140, and then did or did not require these courses for their major. The study also looks at variables that might predict subsequent major choice.

Sample Sizes

The number of freshmen who entered UW in 1992 was 3724. As of winter, 1999, 2317 (62.2%) of these students had graduated. The number of students who took MATH 124 and CHEM 140 is found in [Table 1](#), along with the number who passed, failed, or withdrew from each course. Passing the course is defined as receiving a grade of 0.7 or above. The number of students who passed both courses was 831, or 22.3% of the entering freshman class. For MATH 124, 191 students enrolled in the course twice and 16 three times. For CHEM 140, 96 students enrolled in the course twice and 5 three times. Students were considered to have passed the course if they passed any of their tries.

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AP Credit

Students can receive credit for MATH 124 by means of Advance Placement Testing or by enrolling in another college. Our database does not directly contain this information. However, we can infer that a student had received credit for MATH 124 by his/her enrollment in MATH 125 or MATH 126. Math 124 is required for both classes. The number of students who were not enrolled in Math 124 but were enrolled in Math 125 and/or MATH 126 was 345. An additional 25 students majored in a program that required MATH 124 but did not enroll in MATH 124, 125, or 126. We will label these 370 students as AP credit students.

In contrast, the Chemistry Department does not award credit for an AP score in the chemistry exam. A student scoring high enough can be exempt from taking CHEM 140. Virtually every adviser, including the ones in chemistry tells students not to skip the introductory courses. Since students do not get credit for these courses, the advice is to almost always taken. Thus, we assume no or very few students in the sample tested out of this course.

Enrollment and Graduation Rates

[Table 2](#) presents the graduation rates for students who passed each course, those who withdrew or failed, and those who never enrolled. For each course, the rates for those who passed are higher than for those who either did not enroll in the courses or enrolled and failed to pass. All differences are statistically significant. Students who passed both courses had a graduation rate of 69.7% without the AP students ($n = 831$) and a rate of 70.4% with the AP students ($n = 1201$).

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Entering Data

[Table 3](#) compares students who enrolled in and passed either or both MATH 124 and CHEM 140 with those who did not on High School Grade Point Averages (HSGPA), SAT Math scores, and SAT Verbal scores. AP students are included in the analyses for MATH 124. Students who passed the courses had significantly higher HSGPA's and SAT Math scores. SAT Verbal scores were practically equal for the two CHEM 140 groups, but significantly higher for the students who passed 124 and both courses.

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Requirements of the Final Major

The students in the sample who graduated did so in 104 distinct majors. Five of these were at the Bothell and Tacoma campuses, representing 14 students, and were eliminated from further analyses. The remaining majors, and programs within majors where necessary, were placed into three categories for each of the two courses:

- Those programs that required the course (Required)
- Those programs that required the course or an alternative (Optional)
- Those programs that did not require the course (Not required)

All majors of students with more than one major were taken into account, but each student is counted only once. For example, if one major required MATH 124 but the other did not, the student was counted as being in a major that required this course.

The number and percentage of students who took MATH 124 and CHEM 140, including those who did not graduate, within each of the above categories is found in [Table 4](#). Note that students who did not graduate were not classified.

Thus, we see that about 23% and 25% of the students who passed MATH 124 and CHEM 140, respectively, needed to take the course as a requirement. If one excludes those who did not graduate, the percentages increase to about 33 and 38, respectively. Of those who graduated, 27.9% of the MATH 124 students and 46.2% of the CHEM 140 students ended up using the respective course as an elective. Thus, clearly the assumption that many students who take these courses really do not need them is borne out. Of course, there may be value in taking the course anyway, but we are not making that argument here.

The Course as Optional for the Major

Majors and programs within majors for which MATH 124 or CHEM 140 were optional were ones, of course, in which the requirements could be met by another course. MATH 124 was optional for the major of 709 of the entire cohort who graduated. Of these, 414 (56.8%) passed MATH 124 and thus apparently met the requirement with it. CHEM 140 was optional for the major of only 176 of the graduates, but only 24 (15.8%) met the requirement by taking it. [Return to text](#)

Predictors of Need for the Courses

Is it possible to predict in advance who will be taking the two courses as a requirement of their eventual major? We explore this question by looking at high school grade point average (GPA), SAT scores, and grade in the course. The results for MATH 124 are found in [Table 5](#), and the results for CHEM 140 are found in [Table 6](#). Eta Squared is a statistical measure indexing the percentage of variance in the given measure (e. g., HSGPA) accounted for by differences in the grouping variable.

For both MATH 124 and CHEM 140, all differences were statistically significant except SAT Verbal for both and High School GPA for the latter. One can see, however, that the strongest predictor was the grade received in the course. As indexed by Eta Squared, membership in one of the three groups accounted for more than 18% of the variance in grades for Math 124 and over 12% for CHEM 140. SAT Math scores were also predictive, more so for CHEM 140 (7.9%) than MATH 124 (3.7%). Clearly, students with higher grades in the two courses and with higher SAT Math scores were more likely to choose a major requiring either of these courses. A more compelling view of the predictability of SAT Math scores and course grades can be gained by dividing students into two groups on each of the variables.

SAT Math

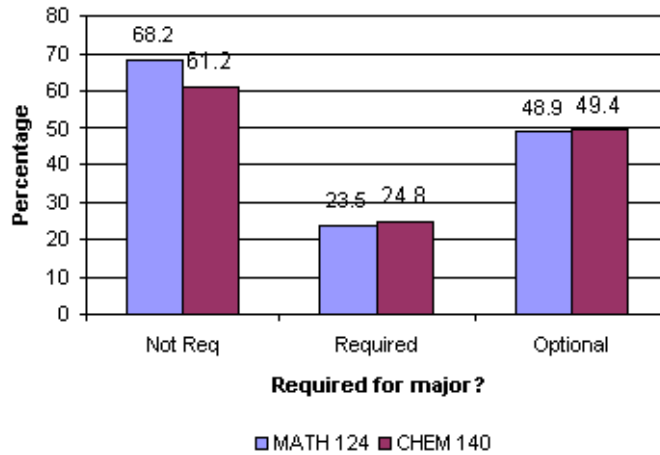
Students were divided into two groups, those with SAT Math scores at 600 or above and those with SAT Math scores below 600. This analysis included all students with SAT scores on file, not just those who took the courses under study. In [Table 7](#) below, we present the percentage of students, within each of the three MATH 124 groups defined above, who scored below 600 or at 600 and above. The same data are available for CHEM 140 in [Table 8](#). One is reminded that Math 124 was an optional requirement for many more majors than was CHEM 140.

One can see enormous differences in percentages from row to row, which are highly statistically significant. These differences are shown in Figure 1 below for students who scored below 600 on the SAT. Put in terms of probabilities, the data indicate that:

- if a student majors in a field that requires MATH 124, he/she has a 23.5% probability of scoring below 600 on the SAT Math,
- if a student does not major in a field that requires MATH 124, he/she has a 68.2% probability of scoring below 600 on the SAT Math, and
- if a student majors in a field for which MATH 124 is optional, he/she has a 48.9% probability of scoring below 600 on the SAT Math.

The comparable probabilities for CHEM 140 are 24.8%, 61.2%, and 49.4 for required, not required, and optional, respectively.

Figure 1. SAT Math below 600

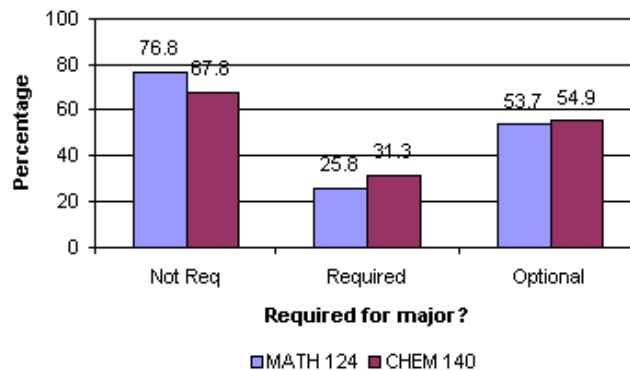


Course Grade

For the grade in each course, we divided students into those who received a 3.0 or above and those who received a grade below 3.0. For this analysis, we included students who withdrew from the given course in the latter group. [Table 9](#) presents the number and percentage in each group for MATH 124; [Table 10](#) presents the same data for CHEM 140.

As above, one can see enormous differences across groups. Students for whom MATH 124 is not a major field requirement had a probability greater than 75% of receiving below a 3.0 in this course. On the other hand, those majoring in an area requiring MATH 124 had nearly a 75% probability of receiving a grade of 3.0 or better. For CHEM 140, the two comparable probabilities reduce to about two-thirds, which still represents a strong relationship. The probabilities for majoring in a program that is optional are close to 50-50. These differences are displayed in Figure 2 below.

Figure 2. Grade below 3.0



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DISCUSSION AND CONCLUSIONS

Of the 1992 entering freshmen class, over 36% enrolled in MATH 124 and over 40% enrolled in CHEM 140. (Another 9.3% of the students gained credit for MATH 124 through Advanced Placement Credit or by some other means.) Students who enrolled in and passed either of these courses had higher average high school GPA's and SAT Math scores, had comparable or better SAT Verbal scores, and graduated at a higher rate, compared to students who did not pass either of these courses. Clearly, by normal academic standards, those who enroll and pass these courses tend to be better students.

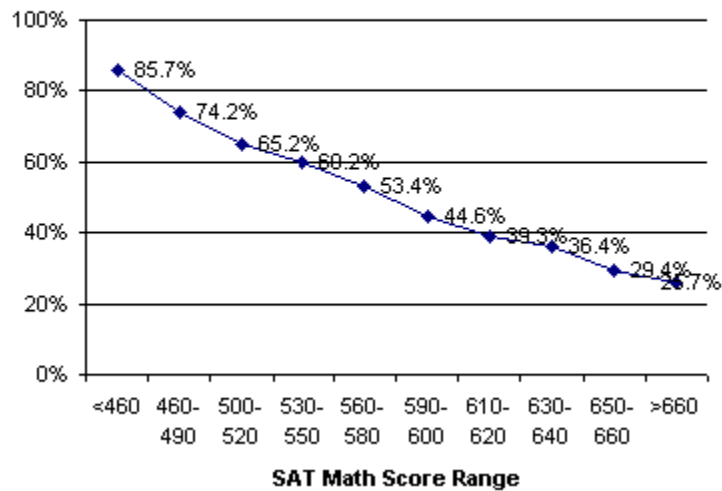
There is unquestionably value in taking these courses in and of themselves. However, we assume that most students enroll because they expect the course to be required for their eventual major or program, such as engineering and pre-med. Yet, analysis of the final majors of the 62.2% of the 1992 freshmen who had graduated showed that nearly two-thirds of those enrolled either did not need the class for graduation or could have fulfilled their requirement by taking an alternative class. For nearly half of the CHEM 140 students, the course was not used to meet the requirements of the major even as an option.

Traditionally, MATH 124 and CHEM 140 are considered gateway courses. Students need to do well in them in order to show their mettle for science-oriented majors. Even though the failure rate was not great, students getting higher grades were more likely to pursue majors requiring the courses. Thus, the courses still function as gateways, either by means of the low grade disadvantaging students' entry into competitive majors or by discouraging students, which in some cases may be a valuable service. In the case of MATH 124, about three-fourths of the students who pursued a major that required MATH 124 received a 3.0 grade or better. Similarly, about three-fourths of the students for whom the class did not end up as a requirement received below a 3.0 grade or withdrew from the class. For CHEM 140 about two-thirds of those who finished a major that did not require this course received grades below 3.0 and about two-thirds of those who finished a major that did require this course received a grade of 3.0 or above.

Unfortunately grades are received after the fact and, thus, cannot be used for advising about whether to take the class in the first place. However, it appears that SAT Math scores can provide useful information for providing students realistic advice on their chances of success and happiness in a science-based curriculum. We showed that 76.5% of the students who majored in a program that required Math 124 scored above 600 on SAT Math and that 75.2% on the students who majored in a program that required CHEM 140 scored above 600 on the SAT Math. The comparable numbers for those students who did not major in areas requiring one or both of the two courses were 31.8% and 38.8% for MATH 124 and CHEM 140, respectively. Thus, students who score below 600 on SAT Math can be reasonably advised that they will probably not graduate in a major that requires either course.

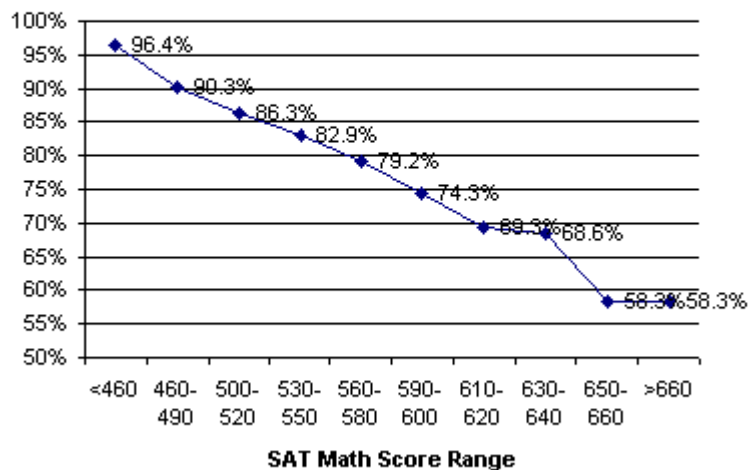
In Figure 3 we present the probability of majoring in a program that that does not require MATH 124 within each of a number of SAT Math score ranges. Again one can see that students with low SAT Math scores are unlikely to complete a major that requires MATH 124. With increases in SAT Math scores, the likelihood of completing a major that requires Math 124, or for which it is an option, steadily increases.

Figure 3. The probability of completing a major NOT requiring MATH 124



In Figure 4, we present the probability of majoring in a program that does not require CHEM 140 by the same SAT Math score ranges. The pattern is the same as for MATH 124. However, since there are relatively fewer majors that either require CHEM 140 or for which it is an option, the probabilities are generally higher at all levels. Nonetheless, the pattern is identical.


Figure 4. The probability of completing a major NOT requiring CHEM 140



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TABLES

| Table 1. Number Enrolling and Grade Outcome | | |
|--------------------------------------------------------|----------|----------|
| | MATH 124 | CHEM 140 |
| Enrolled | 1347 | 1505 |
| Passed | 1172 | 1431 |
| Failed | 20 | 22 |
| Withdrew | 145 | 53 |

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| Table 2. Graduation Rates | | |
|--------------------------------------|------------------|------------------|
| | MATH 124 | CHEM 140 |
| Did Not Enroll | 59.6% (n = 2387) | 59.4% (n = 2272) |
| Passed | 69.4% (n = 1172) | 67.2% (n = 1431) |
| Withdrew or Failed | 53.8% (n = 165) | 33.3% (n = 75) |
| AP Students | 72.2% (n = 370) | |

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| Table 3. Averages on High School GPA and SAT Scores | | | |
|----------------------------------------------------------------------|-------|----------|------------|
| MATH 124 | HSGPA | SAT Math | SAT Verbal |
| Passed | 3.63 | 618.2 | 572.2 |
| Did Not Pass | 3.40 | 548.5 | 548.7 |
| CHEM 140 | | | |
| Passed | 3.61 | 601.3 | 560.2 |
| Did Not Pass | 3.42 | 562.7 | 557.4 |
| Both Courses | | | |
| Passed | 3.62 | 620.6 | 571.4 |
| Did Not Pass | 3.43 | 556.9 | 552.3 |

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| Table 4. Number of Students for Which Course was Required, Optional, or Not Required (Students Who Took Each Course Only) | | |
|--------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------------|
| | MATH 124 | CHEM 140 |
| Required for Major | 269 (23.0%) | 364 (25.4%) |
| Optional for Major | 315 (26.9%) | 152 (10.6%) |
| Not Required for Major | 226 (19.3%) | 443 (31.0%) |
| Did Not Graduate | 362 (30.9%) | 472 (33.0%) |

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| Table 5. Differences among Averages of the Three MATH 124 Groups (Students Who Took MATH 124 Only) | | | | |
|-------------------------------------------------------------------------------------------------------------------------------|-------|----------|------------|--------------|
| | HSGPA | SAT Math | SAT Verbal | Course Grade |
| Not Required for Major | 3.63 | 590.6 | 572.6 | 2.52 |
| Required for Major | 3.70 | 622.2 | 567.4 | 3.33 |
| Optional for Major | 3.71 | 602.8 | 560.0 | 2.88 |
| Eta-Squared | 1.2% | 3.7% | 0.4% | 18.2% |

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| Table 6. Differences among Averages of the Three CHEM 140 Groups (Students Who Took CHEM 140 Only) | | | | |
|-------------------------------------------------------------------------------------------------------------------------------|-------|----------|------------|--------------|
| | HSGPA | SAT Math | SAT Verbal | Course Grade |
| Not Required for Major | 3.63 | 586.0 | 558.2 | 2.66 |
| Required for Major | 3.69 | 628.2 | 568.0 | 3.17 |
| Optional for Major | 3.64 | 589.5 | 564.8 | 2.92 |
| Eta-Squared | 0.5% | 7.9% | 0.3% | 12.9% |

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| Table 7. Number (Percentage) for MATH 124 and SAT Math Score (All Students) | | |
|--------------------------------------------------------------------------------------------|------------------|------------------------|
| | SAT Math Score | |
| | <u>Below 600</u> | <u>At or Above 600</u> |
| Not Required for Major | 744 (68.2%) | 347 (31.8%) |
| Required for Major | 97 (23.5%) | 316 (76.5%) |
| Optional for Major | 347 (48.9%) | 362 (51.1%) |

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| Table 8. Number (Percentage) for CHEM 140 and SAT Math Score (All Students) | | |
|--------------------------------------------------------------------------------------------|------------------|------------------------|
| | SAT Math Score | |
| | <u>Below 600</u> | <u>At or Above 600</u> |
| Not Required for Major | 1002 (61.2%) | 634 (38.8%) |
| Required for Major | 100 (24.8%) | 303 (75.2%) |
| Optional for Major | 86 (49.4%) | 88 (50.6%) |

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| Table 9. | | |
|------------------------------------------------------------|-------------------|------------------------|
| Number (Percentage) for MATH 124 and MATH 124 Grade | | |
| | Grade | |
| | <u>Below 3.0*</u> | <u>At or Above 3.0</u> |
| Not Required for Major | 208 (76.8%) | 63 (23.2%) |
| Required for Major | 70 (25.8%) | 201 (74.2%) |
| Optional for Major | 187 (53.7)% | 161 (46.3%) |

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| Table 10. | | |
|------------------------------------------------------------|-------------------|------------------------|
| Number (Percentage) for CHEM 140 and CHEM 140 Grade | | |
| | Grade | |
| | <u>Below 3.0*</u> | <u>At or Above 3.0</u> |
| Not Required for Major | 316 (67.8%) | 150 (32.2%) |
| Required for Major | 114 (31.3%) | 250 (68.7%) |
| Optional for Major | 84 (54.9%) | 69 (45.1%) |

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* Includes withdrawals

¹ The author wishes to thank Philip Hoffman who was responsible for beginning this follow-up study and Kenneth Etkorn who assessed whether the two courses were required in all major fields.