2002 GC Cohort with STEM Major Interests: High School and College Academic Performance

Elizabeth Jansen, Cathrine Wambach and Jennifer Franko

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ABSTRACT

This study describes the relationship between high school mathematics and science backgrounds and college math and science performances of 163 students who entered General College (GC) in fall of 2003 with interests in science (STEM) majors. The study found low positive correlations between high school and college performance, but no significant differences in the backgrounds of students who eventually left the college and those who persisted. The study found that over half of the original STEM majors left the college after two years and that over half of the remaining students were not enrolled in STEM majors.

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Several studies have found evidence that students entering General College with an interest in pursuing science, technology, engineering, and math (STEM) majors experience academic difficulty and many leave the University (Wambach, Hatfield, Franko, & Mayer, 2003; Jansen, Wambach, & Franko, 2005). The previous studies conducted by ORE to assess the academic patterns of students with STEM major interests have primarily focused on college achievement variables and have not looked at high school achievement. Due to the concern over the persistence rates of those GC students who enter intending to pursue STEM majors, there has been increased interest among GC policy makers about which pre-college variables may predict academic success for this group of students. The present study attempts to extend our knowledge of the academic characteristics of GC students who have STEM interests by looking at both high school and college transcript data.

This study was designed to answer several research questions including the following:

1. What are the high school math and science grades, high school math curriculums, and high school locations of GC students who intend to pursue STEM majors?

2. Do students who wish to pursue STEM majors and leave the University have different patterns of high school achievement and college achievement in math and science than those who continue to persist at the University?

3. Do high school math and science grades correlate with grades in college for persisters and leavers with pre-matriculation STEM interests (i.e., first term GPA and grades in first math and science courses)?

This report will be divided into several sections. The first section will highlight characteristics of the sample including the following: how the sample was selected,

demographics, pre-matriculation interests, average ACT and AAR scores, transfer rates and attendance rates at other institutions and stability of STEM majors. The second section will describe the high school data for the sample split by persisters and leavers including the following: high school descriptions (i.e., location and type), ACT subtest scores, average high school math and science grades, most advanced high school math course attempted, and high school curriculum types. The third section provides college data split by persisters and leavers, which includes the following: GPA, academic achievement categories, and college-level math and science grades. Finally, in the last section correlations between high school and college variables will be presented.

Sample Background

This study used data from University transcripts and high school transcripts to provide a descriptive picture of members of the fall 2002 GC New High School (NHS) cohort whose pre-matriculation interests included STEM majors. Since this cohort has not yet graduated, this report describes the academic patterns of students who continue to persist (persisters) or have left the University (leavers). We were particularly interested in assessing whether high school performance in math and science courses correlate with college academic performance in a student's first GC and non-GC math and science courses.

The academic transcripts of all members of the GC 2002 cohort who had expressed initial interest in one of 9 pre-science or technology majors were obtained from the University of Minnesota data warehouse and used for analysis (N=163). The majors included for analysis were Pre-IT, Pre-Biological Science, Pre-Health Science, Pre-Medicine, Pre-Dentistry, Pre-Veterinary Medicine, Pre-Pharmacy, Pre-Nursing, and Pre-Architecture. By spring 2005, 81 (49.7%) of the students in the sample were persisting and 82 (50.3%) had left the University. Frequencies and

percentages of persisters and leavers with each of the pre-matriculation interests are listed in

Table 1.

Table 1: Pre-matriculation interests of persisters and leavers (percents in parentheses)

Pre-matriculation interest	Leavers	Persisters	Total
Pre IT	35 (42.7)	34 (42.0)	69 (42.3)
Pre Biological Science	23 (28.0)	25 (30.9)	48 (29.4)
Pre-Architecture	8 (9.8)	7 (8.6)	15 (9.2)
Pre Medicine	3 (3.7)	6 (7.4)	9 (5.5)
Pre Health Science	1 (1.1)	1 (1.2)	2 (1.2)
Pre Nursing	6 (7.3)	5 (6.2)	11 (6.7)
Pre Dentistry	3 (3.7)	2 (2.5)	5 (3.1)
Pre Pharmacy	3 (3.7)	1 (1.2)	4 (2.5)
Pre Veterinary Science	0	0	0 (0)
Total	82 (100)	81 (100)	163 (100)

Of the 163 students who met the selection criteria, there were 70 females (42.9%) and 93

males (57.1 %). Leavers consisted of 37 females (45.1%) and 45 males (54.9%), while persisters

consisted of 33 females (40.7%) and 48 males (59.3%). A chi square of gender and group status

(i.e., persisters and leavers) was not significant.

The sample included 78 Caucasians (47.9%), 39 Blacks (23.9%), 34 Asians (20.9%), 9

Hispanics (5.5%), and 3 American Indians (1.8%). Table 2 shows ethnicities for persisters and

leavers. A chi-square of ethnicity and group status (i.e., persisters and leavers) was not

significant.

Table 2: Frequencies and percentages (in parentheses) of ethnic groups of persisters and leavers

Ethnicity	Leaver	Persister
Caucasian	42 (51.2)	36 (44.4)
Black	17 (20.7)	22 (27.2)
Asian	17 (20.7)	17 (21.0)
Hispanic	3 (3.7)	6 (7.4%)
American Indian	3 (3.7)	0
Total	82 (100)	81 (100)

Students' ACT test scores and high school ranks were similar to those of the total GC 2002 NHS cohort. Composite ACT scores, which were available for 155 students, ranged from 11-31 with a mean of 20.2 (SD= 4.3). AAR scores, which were available for 137 students, ranged from 49-126 with a mean of 92.3 (SD=14.9). High school rank, which was available for 141 students, ranged from 8-99 with a mean of 54.5 (SD=15.2).

High School Data

High school descriptions

Prior studies conducted by ORE have categorized high schools in two ways: One categorized high schools primarily by their geographic location (see Table 3). The other categorized the high schools primarily by type including the following: rural, urban, first ring suburban or second ring suburban schools (see Table 4). In the current study, we categorized the high schools of all students using both categorization systems. The majority of the students came from suburban high schools (37.42%) followed by urban high schools (31.29%). The largest portion of the suburban students came from second ring southeast and southwest suburbs (e.g., Burnsville, Minnetonka, Eden Prairie, Apple Valley). The frequencies for persisters and leavers in the two categories are listed in tables 3 and 4.

Table 3: High schools classified by location

High School Description	Leavers	Persisters	Total N	Total %
Minneapolis	13	15	28	17.18%
St. Paul high	13	10	23	14.11%
Northeast suburban	8	6	14	8.59%
Northwest suburban	3	4	7	4.29%
Southeast suburban	5	12	17	10.43%
Southwest suburban	12	11	23	14.11%
Private Minnesota	1	2	3	1.84%
Alternative or other type	4	2	6	3.68%
Outside metro area Minnesota	13	16	29	17.79%
Non-Minnesota	10	3	13	7.98%
Total	82	81	163	100.00%

Table 4: High schools classified by type

High School Description	Leavers	Persisters	Total N	Total %
Urban/Mpls/St. Paul	26	25	51	31.29%
First ring suburb	8	11	19	11.66%
Second ring suburb	20	22	42	25.77%
Outside metro area	13	16	29	17.79%
Private or other	1	2	3	1.84%
Alternative	0	1	1	0.61%
Wisconsin	7	1	8	4.91%
North/South Dakota	2	0	2	1.23%
Other US City	0	2	2	1.23%
GED	5	1	6	3.68%
Totals	82	81	163	100.00%

ACT scores

We also examined the ACT subscale scores and composite scores for the leavers and

persisters. The mean scores are reported in Table 5. A one-way ANOVA was used to compare

group means on the subtest and composite scores, but no significant differences were found,

although leavers' mean scores were slightly higher on all subtests.

Table 5: Means and standard deviations (in parentheses) of ACT scores by subgroup

ACT score	Leavers	Persisters
English subtest	18.7 (5.2)	18.0 (5.1)
Math subtest	20.6 (4.5)	20.5 (4.5)
Reading subtest	21.5 (5.8)	19.8 (5.4)
Science reasoning subtest	21.2 (4.5)	20.0 (4.0)
Composite score	20.7 (4.4)	19.7 (4.1)

Average high school math and science grades

One unique aspect of this study was that in addition to college transcripts and high school

ranks, high school transcripts were obtained. High school grades were available for 77 (93.9%)

leavers and 79 (97.5%) persisters. In order to form a composite measure of high school math

grades for all high school math courses for which a grade had been earned letter grades were

converted into the numeric 0-4.0 grading system used by the University. There were no plus or

minus grade designations given on the high school transcripts. Note that grades for courses taken

as seniors were not included in this calculation since those courses were in progress when

students applied to college. After conversion to numbers, all math grades were added and

averaged. The identical procedure was used to create a composite measure of average high

school science achievement. These two measures will be referred to as the average high school

math grade and the average high school science grade.

The average high school math and science grades were calculated for leavers and persisters. The mean of the average high school math grade for leavers was 3.3 (S.D. = .70) on a 4.0 scale, which equals B+ letter grades. The mean for persisters was 3.5 (S.D. = .76), which equals between an A- and B+ letter grade. The mean of the average high school science grade for leavers was 3.3 (S.D. = .64), while the mean for persisters was 3.4 (S.D. = .60). Thus, both groups had a B+ average high school science grade. A one-way ANOVA revealed no significant differences between groups on either average high school math or average high school science grades.   This finding indicates that mean high school grades for both leavers and persisters were in the B range (i.e., 2.66-3.33).

The mean of the average high school math and science grades was also calculated by ethnicity (see Table 6). Due to small sample size, the Native American group was not included in these analyses.

Table 6: Average of the mean and SD (in parentheses) high school math and science grades by ethnic group.

Ethnicity	N	Mean for high school math	Mean for high school science
White	75	3.36 (.62)	3.28 (.60)
Black	36	3.31 (.89)	3.45 (.69)
Asian	33	3.48 (.82)	3.16 (.41)
Hispanic	11	3.40 (.77)	3.72 (.77)

A one-way ANOVA was conducted to test group differences in the means. The ANOVA revealed that there was a significant difference in average high school science grades (F (3, 150) =3.05, $p < .05$). Post hoc analyses revealed that the mean of the average high school science grade for the Hispanic group was significantly higher than that of the Asian group. There were small sample sizes in several ethnic categories, thus, the findings require cautious interpretation.

Finally, an ANOVA was calculated to determine differences in average high school math grades by high school classification. A similar ANOVA was conducted for average high school science grade and high school classification type. There were no significant findings with either high school classification system.

Most advanced high school math course attempted

There were many individual differences in the number of math courses taken and the type of math courses (e.g., calculus versus algebra). In addition, the format of the curriculum (e.g., usage of the integrated math sequences or more traditional math sequences) varied between high schools. We coded for the most advanced high school math course attempted for each student (see Table 7). This includes courses that were taken as a senior and labeled as "in progress." Given the diversity of math courses offered by high schools, it was not always clear which math course was the most advanced. In ambiguous situations, the last math course attempted was used. It is interesting to note the wide diversity of last math courses attempted. As seen in Table 7, there are similar numbers of persisters and leavers in advanced math courses (e.g., calculus and pre-calculus) intermediate courses (e.g., trigonometry and intermediate algebra) and lower level-math courses (e.g., elementary algebra and geometry).

Table 7: Frequencies of most advanced high school math course attempted by persisters and

leavers

Math course	Leavers	Persisters	Total
Calculus	14 (17.7)	16 (19.8)	30 (18.8)
Pre-Calculus	16 (20.3)	18 (22.2)	34 (21.3)
Integrated 3	9 (11.4)	6 (7.4)	15 (9.4)
Trigonometry	13 (16.5)	16 (19.8)	29 (18.1)
Intermediate Algebra	12 (15.2)	12 (14.8)	24 (15.0)
Integrated 2	1 (1.3)	0	1 (.6)
Senior Math	2 (2.5)	0	2 (1.3)
Integrated 1	1 (1.3)	0	1 (.6)
Analysis	3 (3.8)	4 (4.9)	7 (4.4)
Advanced Math	2 (2.5)	3 (3.7)	5 (3.1)
Geometry	2 (2.5)	4 (4.9)	6 (3.8)
Elementary Algebra	0	1 (1.2)	1 (.6)
Missing	4 (5.1)	1 (1.2)	5 (3.1)
Totals	79 (100)	81 (100)	160 (100)

High school math and science curriculum sequences

High school curriculums were categorized as using either more traditional course

sequences (e.g., Algebra, Geometry, Trigonometry, Pre-Calculus, and Calculus) or integrated

sequences (e.g., Integrated I, Integrated 2, and Integrated 3). Since students varied in the amount

and types of math courses attempted, it was not always possible to definitively determine which

curriculum an individual student experienced. For purposes of these analyses, a student was

coded as having taken an integrated curriculum if they had either Integrated I, Integrated 2, or

Integrated 3 on their transcript, all other students were coded as having a traditional curriculum.

Twenty (24.4%) leavers and 25 (30.9%) persisters experienced the integrated math curriculum.

A chi square analysis on curriculum type and group status (i.e., leavers and persisters) was not

significant. An ANOVA was conducted to test for differences in the average high school math

grade for those with the two curriculum types, but no significant differences were found.

We also assessed which high schools offered integrated curriculums. In this sample, 17

urban Mpls/St.Paul schools, 10 first ring suburban schools, 15 second ring suburban schools, and

3 schools outside the metro area had students who took the integrated curriculum. A chi-square

analysis revealed that there is evidence that high school type (i.e., urban, first ring suburb, second

ring suburb and outside of metro area) is related to curriculum type (i.e., integrated or traditional)

[χ^2 (10, n=163) =20.9, $p<.05$]. A comparison of observed and expected frequencies suggests that

students from the first and second ring suburbs are more likely to have taken the integrated

curriculum and students from urban schools or schools outside the metro area are more likely to

have taken the traditional curriculum.

College Data

<u>Transfer data</u>

Overall, 82 (50.3%) students transferred out of GC to another college at the University,

while 81 (49.7%) left before transfer or were persisters who had not yet transferred out of GC.

Only 12 (14.6%) of the students categorized as leavers had achieved transfer by spring 2005,

while 70 (86.4 %) of the persisters had transferred. The colleges that students transferred into

are shown in Table 8.

Table 8: Colleges where persisters and leavers transferred

Transfer College	Leavers	Persisters	Total
Liberal Arts	12 (100)	39 (55.7)	51 (62.2)
Institute of Technology	0	9 (12.9)	9 (11.0)
Biological Sciences	0	9 (12.9)	9 (11.0)
Agriculture, Food, and Environmental Science	0	3 (4.3)	3 (3.7)
Continuing Education	0	3 (4.3)	3 (3.7)
Human Ecology	0	3 (4.3)	3 (3.7)
Education and Human Development	0	1 (1.4)	1 (1.2)
Natural Resources	0	1 (1.4)	1 (1.2)
Nursing	0	1 (1.4)	1 (1.2)
Architecture & Landscape Design	0	1 (1.4)	1 (1.2)
Total	12 (100)	70 (100)	82 (100)

Stability of STEM major choice

We assessed whether or not persisters and leavers had remained in a STEM major during their tenure at the University. For those students who had declared a major, this major was used. For the students who had not yet declared a major, the last recorded major interest on transcripts were used to determine a STEM or non-STEM major academic plan.

In doing this analysis, it was found that a large group of students who transferred to CLA (the most common college of transfer for both groups) had not declared a major and, thus, remained either undecided or undeclared. Specifically, 12 out of the 12 (100%) leavers who transferred were undeclared or undecided and 26 of the 70 (37.1%) persisters who transferred were undeclared or undecided. The numbers and percentages of students remaining in STEM majors, transferring to non-STEM majors, or remaining undecided/undeclared are listed in Table 9.

Table 9: Frequencies and percentages of students who remained in STEM majors.

Last Recorded Major or Major Interest	Leavers	Persisters
STEM	70 (86.4)	33 (40.7)
Non-STEM	0	22 (27.2)
Undeclared/Undecided	12 (14.6)	26 (32.1)
Total	82 (100)	81 (100)

<u>Life after leaving: Attendance at another institution</u>

We also assessed if leavers had attended other academic institutions after leaving the University. A search of the National Student Clearinghouse data revealed that 27(32.9%) of the 82 leavers had records indicating enrollment at another institution. Of these students who continued to pursue post-secondary education, 11 subsequently enrolled in a 4-year school and 16 enrolled in a community or technical college. Three students attended more than one institution after leaving the University of Minnesota.

These students who had evidence of enrolling in another institution were not found to be significantly different from the rest of the leavers on a variety of factors. There were 14 White, 5 Black, 5 Asian, 2 Hispanic and 1 American Indian student in this group. A chi-square on ethnicity and enrolling in another institution was not significant. The mean first term GPA of students who left the University and had records indicating enrollment at another institution was 2.26 (SD = 1.1) and mean last term GPA was 1.89 (.97). An ANOVA comparing leavers who have evidence of enrolling at another institution and leavers who do not enroll at another institution was not significant indicating that the two groups do not differ on mean first term or last term GPA. As for pre-matriculation interests, 17 (63.0%) of those students who had evidence of enrolling at another institution had a pre-matriculation interest in IT, 4 (14.8%) biological science, 3 (11.1%) nursing, 2 (7.4%) architecture, and 1 (3.7%) health science.

GPA

The cumulative GPAs during the first semester of enrollment at the University were analyzed. Twenty-nine (35.4%) leavers had a first term GPA below 2.0, while only 2 (2.5%) persisters had a first term GPA below 2.0. The mean first term GPA for leavers was 2.3 (S.D. = 1.2) and for persisters was 3.0 (S.D. =.63). A one-way ANOVA was conducted to test differences in means between groups. There was a significant difference between first term GPAs for the two groups (F=25.5 (1, 162), $p < .01$).   This indicates that persisters had significantly higher mean first term GPAs than leavers.

In addition, we examined the cumulative GPA during their most recent term of enrollment. For persisters this was spring 2005 and for leavers this was the last term for which they were enrolled at the University. Leavers had a mean cumulative GPA of 1.8 (SD= 1.0) and persisters had a mean cumulative GPA of 2.7, (S.D=. 44). A one-way ANOVA revealed

significant differences in mean cumulative GPA between groups   (F=46.9 (1, 162), $p < .01$).

This indicates that persisters had significantly higher mean cumulative GPAs than leavers.

Academic standing categories

In order to better understand the academic difficulties of the GC students interested in pursuing STEM majors, we grouped all students into three categories based on their academic standing. The first group, labeled good academic standing, did not have any suspension or probation records in their student records. The second group had evidence of probation status at some time in their tenure at the University. The final group had evidence of being on suspension at some time during their tenure at the University. The frequencies of each academic achievement category for persisters and leavers is shown in Table 10.

Table 10: Academic standing categories for persisters and leavers

Academic category	Leavers	Persisters	Total
Good academic standing	31 (37.8)	53 (65.4)	84 (51.5)
Probation	33 (40.2)	27 (33.3)	60 (36.8)
Suspension	18 (22.0)	1 (1.3)	19 (11.7)
Total	82 (100)	81 (100)	163 (100)

A chi-square analysis revealed that there is evidence that academic standing category membership (i.e., good standing, probation, and suspension) is related to student group membership (i.e., persister or leaver) [χ^2 (3, n=163) =23.3, $p<.01$]. A comparison of observed and expected frequencies suggests that leavers are more likely to be in the suspension and probation groups and persisters are more likely to be in the good academic standing group.

Description of college-level math and science grades

We were particularly interested in assessing how well students did in the math and science courses that they attempted while at the University. In the following tables (11-15) grades for individual courses will be reported for persisters and leavers. Titles of all courses are provided in Appendix A. Next, statistical comparisons of mean grades in first GC math, first GC science, first non-GC math, first non-GC science are reported (see Table 16).

Forty-two (51.2%) of the leavers and 41 (50.6%) of the persisters took a GC math course which included GC 0712, GC 0716, GC 0721, GC 0722, GC 0731, or GC 0732.   The course most commonly enrolled in by both groups was 0731/32. The grades for the first GC math course attempted are listed in Table 11.

Table 11: Frequencies of grades for first GC math course for persisters and leavers

GC Math	A		B		C		D		F/N/I/W		Total
	L	P	L	P	L	P	L	P	L	P	
0712	0	0	1	0	0	0	0	0	1	0	2
0716	0	0	0	0	1	0	1	0	1	0	3
0721/0722	2	3	2	2	2	2	1	0	3	0	17
0731/0732	8	16	12	8	5	5	0	0	2	5	61
Total	10	19	15	10	8	7	2	0	7	5	83

Note: L=leavers, P=Persisters

We also counted the frequencies of grades earned in the first non-GC math course attempted. Forty-eight (58.5%) of the leavers and 70 (86.4%) of the persisters took a non-GC math course (i.e., from the math department). The course most commonly enrolled in by both groups was Math 1151 followed by Math 1031. The frequencies of grades for the first non-GC math course attempted are listed in Table 12.

Table 12: Frequencies of grades for first non-GC math course for persisters and leavers

Non-GC Math	A		B		C		D		F/N/I/W		Total
	L	P	L	P	L	P	L	P	L	P	
1001	0	0	0	0	0	0	0	1	0	0	1
1031	0	1	1	3	2	7	3	2	6	1	26
1051	4	7	6	12	6	7	2	3	10	5	62
1131	1	1	0	0	1	1	1	0	0	0	5
1151	0	1	0	4	0	0	0	0	0	0	5
1155	0	1	1	2	0	0	0	0	0	0	4
1271	1	1	0	4	0	2	1	1	0	0	10
1272	0	1	0	0	0	0	1	1	1	0	4
1371	0	0	0	0	0	1	0	0	0	0	1
Total	6	13	8	25	9	18	8	8	17	6	118

Note: L=leavers, P=Persisters

Math 1271, Calculus, is a prerequisite course for many advanced math and science courses that has been of interest in past studies of STEM majors (Jansen, Wambach, & Franko, 2005b). Math 1271 was attempted by 12 (14.6%) of the leavers and 38 (46.9%) of the persisters. The grades in Math 1271 for leavers and persisters are listed in Table 13.

Table 13: Math 1271 grades for leavers and persisters

Grade	Leavers	Persisters	Total
A	1	2	3
B	1	9	10
C	1	17	19
D	2	4	6
F/N/W	7	6	13
Total	12	38	51

In addition, we counted the frequencies of grades earned in the first GC science courses attempted. Fifty-six (68.3%) of the leavers and 55 (67.9%) of the persisters took a GC science course which included all of the GC 11XX courses. The course most commonly enrolled in by

both groups was GC 1131 followed by GC 1135. The grades for the first GC science course attempted are listed in Table 14.

Table 14: Frequencies of grades for first GC science course for persisters and leavers

GC Science	A		B		C		D		F/N/I/W		Total
	L	P	L	P	L	P	L	P	L	P	
1111	0	0	0	1	0	2	0	0	1	0	4
1112W	0	1	0	0	0	0	0	0	0	0	1
1131	1	4	3	12	6	4	9	3	5	4	51
1135	4	9	7	6	4	1	1	0	4	0	36
1163	1	2	0	0	2	1	0	0	2	0	8
1166	1	0	0	0	0	0	0	0	0	0	1
1171	1	1	1	3	2	1	0	0	1	0	10
Total	8	17	11	22	14	9	10	3	13	4	111

Note: L=leavers, P=Persisters

We also counted the frequencies of grades earned in the first non-GC science course attempted. Thirty (36.6%) of the leavers and 60 (74.1%) of the persisters took a non-GC science course. The course most commonly enrolled in by both groups was Chem 1011 followed by Chem 1021. The frequencies of grades for the first non-GC science course attempted are listed in Table 15.

Table 15: Frequencies of grades for first non-GC science course for persisters and leavers

Non-GC Science	A		B		C		D		F/N/I/W		Total
	L	P	L	P	L	P	L	P	L	P	
Bio 1001	1	0	1	1	0	1	0	0	1	0	5
Bio 1009	0	0	0	1	1	1	0	0	1	1	5
Bio 1905	0	0	0	1	0	0	0	0	0	0	1
Chem 1011	1	0	3	14	5	15	4	2	6	2	52
Chem 1021	1	1	0	3	1	3	0	2	2	4	17
Chem 1022	0	0	0	0	0	2	0	0	0	0	2
Geo 1001	0	0	0	0	0	0	0	0	0	1	1
Phys 1101W	0	1	1	1	0	0	0	1	1	0	5
Phys 1301W	0	1	0	2	0	3	0	0	0	0	6
Total	3	3	5	23	7	20	4	5	11	9	94

Note: L=leavers, P=Persisters

A series of one-way ANOVAs were conducted to test for significant differences in the mean grades between groups of students for the following courses: first GC math course, first GC science course, first math course outside of GC, Math 1271, and first science course outside of GC. Mean grades for these courses are presented in Table 16. The results of the ANOVAs are included in Table 16. As shown in Table 16, there were significant group differences for all comparisons with the exception of GC math courses. A review of the means revealed that for all achievement variables except GC math, leavers had significantly lower grades than persisters.

Table 16: Group differences in college achievement variables

College achievement variables	Leavers Mean	Persisters Mean	df	F	Sig.
GC math	B (3.00)	A-/B+ (3.5)	1,77	3.39	0.069
GC science	C (2.0)	B (3.0)	1,111	12.16	.001**
Non-GC math	C/C- (1.7)	B (3.0)	1,103	13.34	.001**
Non-GC science	C (2.0)	B (3.0)	1, 86	11.7	.001**
First term GPA			1,162	25.47	.001**
Last term GPA			1, 162	47	.001**

Note: ** indicates significant at $p <.01$ level (two-tailed)

Total math and science courses with low grades

Besides the first math and science courses, we were also interested in the total number of math and science courses in which each leaver and persister experienced academic difficulty. We summed the total number of D or lower grades that each participant received in all math courses attempted (i.e., GC math courses and non-GC math courses). The results for math and science are presented in Table 17. As can be seen from the table, roughly half of both groups of students had academic difficulty in at least one math course.

Table 17: Frequency of D or lower grades in math courses by student group

Frequency	Leavers	Persisters
0	43 (52.4)	48 (59.3)
1	29 (35.4)	22 (27.2)
2	10 (12.2)	9 (11.1)
3	0	2 (2.5)
Total	82 (100)	81 (100)

Similarly, we counted the total number of D or lower grades that each participant received in all science courses attempted (i.e., GC science courses and non-GC science courses). The results are presented in Table 18. As can be seen from the table, it seems that a larger

percentage of leavers (57.3%) had academic difficulty in science courses than persisters (42%)

did. Many students from both groups, however, had some academic difficulty in science courses.

Table 18: Frequency of D or lower grades in science courses by student group

Frequency	Leavers	Persisters
0	35 (42.7)	47 (58.0)
1	32 (39.0)	21 (25.9)
2	8 (9.8)	9 (11.1)
3	6 (7.3)	3 (3.7)
4	1 (1.2)	1 (1.2)
Total	82 (100)	81 (100)

Relations between High School and College Grades

<u>Correlations between high school grades and college academic variables</u>

In order to address the final research question, regarding the relation between high school

math and science achievement and college math and science achievement, a series of correlations

were run between the average high school math and science grades and the college achievement

variables. Since the means of the average science grades or average math grades did not vary

significantly between persisters and leavers, correlations were run for the entire sample, not split

by group.

Table 19: Correlations between average high school grades and college math and science grades and GPA for full sample (n in parentheses).

	GC math	GC science	Non-GC math	Non-GC science	First term GPA	Last term GPA
Average high school math	.258* (74)	.357** (106)	.303** (100)	.153 (85)	.199* (156)	.297** (156)
Average high school science	.240* (73)	.311** (104)	.136 (98)	.332** (83)	.194* (154)	.182* (154)

Note: * indicates significant at $p < .05$ level (two-tailed)
       ** indicates significant at $p < .01$ level (two-tailed)

As can be seen in Table 19, both average high school math and average high school science grades significantly correlate with all college achievement variables with the exception of two grades. The first non-GC science grade was only significantly correlated with average high school science grade and first non-GC math grade was only significantly correlated with average high school math grade.

In addition, we analyzed the relation between level of most advanced high school math course and the first non-GC college math grade. A one-way ANOVA revealed no significant results.

High school math curriculum type and college achievement

We were also interested in assessing whether those students who experienced the integrated curriculum had differences in college achievement compared to those students who experienced a traditional curriculum in high school. We used first term GPA and grade in first non-GC math course as indicators of college achievement. A series of one-way ANOVAs did not reveal significant differences in first term GPAs or grades in first non-GC math courses for those who took integrated curriculum versus traditional curriculum.

High school descriptions (location and type) and college achievement

A series of one-way ANOVAs were run to assess differences in college achievement variables (i.e., first term GPA, first non-GC math grade and first non-GC science grade) by students coming from high schools with different locations and types. The ANOVAS revealed no significant differences in college achievement variables by high school location or type.

Discussion

In this study we explored the high school and college characteristics of persisters and leavers from the fall 2002 GC NHS cohort who wanted to pursue STEM majors. We explored the high school and college data available for the sample to assess if high school data provided important information in understanding the academic patterns of persisters and leavers who pursue STEM majors. This sample was similar on demographic variables to other samples of students who had pre-matriculation interests in STEM majors (Jansen et al., 2005).

First, we assessed differences between persisters and leavers based on their high school characteristics. Academically, there were not many differences between persisters and leavers on these variables. There were no significant differences between groups on average ACT or average high school math and science grades. There was also only limited evidence of any differences in high school average math and science grades based on ethnicity. Due to small sample sizes, further study of average high school grades and ethnicity would be needed before any conclusions can be drawn. These findings suggest that these high school achievement variables are not likely to accurately discriminate future leavers and persisters during the college admissions process. Thus, the use of high school grades for the selection of students who wish to pursue STEM majors may have limited utility in the admission process.

In this sample, 32.9% of the leavers had evidence of having enrolled in another institution. In a similar cohort, around 40% of leavers had evidence of enrollment in another

institution. This suggests that leavers who had pre-matriculation interests in STEM majors may be under enrolling at other institutions compared to the other cohorts of GC leavers.

High school curriculum (i.e., integrated or traditional) and most advanced math course taken were also explored as variables that might relate to persistence or leaving.   Similar numbers of persisters and leavers, however, experienced each curriculum type and enrolled in the most advanced math courses (e.g., 14 leavers and 16 persisters attempted calculus). This suggests that, similar to the average high school math and science grades, curriculum type or most advanced math course do not differentiate between future persisters and leavers among students with STEM interests. It is interesting to note that the integrated math curriculum was most prevalent in the suburban schools, while the urban schools and those outside the metro area were more likely to use traditional math curriculums.

Although persisters and leavers were hard to distinguish on academic variables in high school, there were many academic differences between groups after they entered the University. The results of this study support prior findings that after entrance to college, persisters and leavers have significant differences in many performance indicators (e.g., Jansen et al., 2005). Leavers had both lower first non-GC math, GC science and non-GC science grades, and lower first and last term GPAs than persisters. Leavers were also significantly more likely than persisters to have evidence of probation or suspension.

Despite the significant differences in many college achievement variables, both persisters and leavers experienced some academic difficulties during their tenure at the University. For example, approximately half of both groups had at least one grade of D or lower in a math course. Similar numbers of students received a D or lower grade in a science course. In addition, similar numbers of persisters and leavers received an F, N, or W in Math 1271, while more

persisters than leavers earned a D in that course. Since Math 1271 is a prerequisite for many

STEM majors, this suggests that many persisters are also experiencing difficulties in successfully

pursuing a STEM major. Also, over a third of persisters experienced probation or suspension.

This is higher than the non-STEM persister rate (27.5%) from the same cohort. It seems,

therefore, that if persisters continue to pursue STEM majors, they may experience additional

academic difficulties and therefore be at risk of leaving the University.

We also assessed the stability of STEM interests over time. Among leavers, the majority

left while still pursuing a STEM major. This may indicate a resistance to changing major pursuits

despite difficulties in courses that are needed to pursue STEM majors. It might also indicate

more general academic difficulty among this group. Among those leavers who transferred

(n=12), however, all transferred to CLA and became undeclared or undecided. This suggests

that there is little long-term continuation of STEM pursuits among this group. Among persisters,

over half either chose a non-STEM major or remained undecided or undeclared at the time of

this study. The most frequent college of transfer among this group, like leavers, was CLA. The

finding that so many students with initial STEM interests become undeclared or undecided is

alarming given previous findings that those who remain undecided at transfer often experience

further difficulties and tend to leave at a higher rate than students with declared majors (Jansen et

al., 2005).

One of the major purposes of the current study was to assess the relation between high

school variables and college achievement. There were significant but low positive correlations

between average high school math grade and several college variables including: first GC math

grade, first GC science grade, first non-GC math grade, first term GPA, and last term GPA.

There were also significant but low positive correlations between average high school science

grade and the following: first GC math grade, first GC science grade, first non-GC science grade, first term GPA, and last term GPA. These findings indicate that there is some relation between high school grades and later college grades, which could suggest some usefulness of using high school math and science grades as an indicator of later college math and science achievement. It is important to note, however, that there were no significant differences between groups (i.e., persisters and leavers) on average math and science grades, and thus, these correlations were not run by group. Thus, these average high school math and science grades may be a general indicator of college grades, but do predict who will or will not persist.

In conclusion, there were several important findings in the present study. In general, the high school variables did not significantly relate to college academic achievement. There was no relation between curriculum type, high school location or type, or most advanced high school math and any of the college achievement variables (either for the whole sample or split by group). There is little evidence to suggest that the high school indicators that we included in this database were significantly different between the leavers and persisters. Therefore, the use of these high school variables for the admission process may be of limited use. In addition, the findings of this study highlight the large number of students who have a pre-matriculation interest in STEM majors and who remain undecided, which has been found to be associated with further academic problems and leaving in previous studies.

References

Jansen, E., Wambach, C., & Franko, J. (2005). *1999 GC students with STEM major interests*.

Twin Cities, MN: University of Minnesota General College

Wambach, C., Hatfield, J., Franko, J., Mayer, A. (2003). *General college persisters and leavers:*

A comparative study. Twin Cities, MN: University of Minnesota General College.

Appendix A

List of Math and Science Courses

GC Math Courses

0712	Introductory Algebra part 1
0716	
0721/0722	Introductory Algebra
0731/0732	Intermediate Algebra

Non-GC Math Courses

Math 1001	Excursions in Mathematics
Math 1031	College Algebra
Math 1051	Precalculus I
Math 1131	Finite Mathematics
Math 1151	Precalculus II
Math 1155	Intensive Precalculus
Math 1271	Calculus I
Math 1272	Calculus II

GC Science Courses

1111	Weather and Climate
1112W	Environmental Problems
1131	Principles of Biological Science
1135	Human Anatomy and Physiology
1163	Physical Systems
1166	Principles of Chemistry
1171	Physical Geology

Non-GC Science Courses

Bio	1001	Introductory Biology I: Evolutionary and Ecological Perspectives
Bio	1009	General Biology
Bio	1905	Freshman Seminar for the Biological Sciences
Chem	1011	Introductory Chemistry
Chem	1021	Chemical Principles I
Chem	1022	Chemical Principles II
Geo	1001	Earth and Its Environments
Phys	1101W	Introductory College Physics
Phys	1301W	Introductory Physics for Science and Engineering I