

1999 GC Students with STEM Major Interests

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Past studies have demonstrated that GC students who choose science and technical majors graduate at lower rates than other GC students (Wambach, Hatfield, Franko, & Mayer, 2003). The current study was designed to look at the academic records of GC students who indicated a pre-matriculation interest in pursuing a major in science, technology, engineering or math fields (STEM). We had several research questions including:

1. Do students who wish to pursue a STEM major who leave the University have different academic patterns (e.g., lower GPAs, more withdrawals, more Fs, etc.) than those students who persist or graduate?
2. Do students who wish to pursue STEM majors and continue to persist or graduate, remain in STEM majors or change to other majors?
3. Which GC and non-GC courses do STEM graduates, persisters, and leavers withdraw from or fail?
4. What sequences of math courses do STEM graduates, persisters, and leavers attempt?

This study used data from student transcripts to provide a descriptive picture of members of the fall 1999 GC New High School (NHS) cohort whose pre-matriculation interests included several STEM majors. This report describes the academic patterns of students who graduated, continued to persist, or left the University. We were particularly interested in assessing whether or not there were differences in several academic patterns (e.g., number of failures in GC and non-GC courses, number of repeated courses, etc.) evident in the transcripts of students with STEM interests.

Description of 1999 Students with STEM Interests

The academic transcripts of all members of the GC 1999 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=180). 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. Proportions of graduates, persisters, and leavers with each of the pre-matriculation interests are listed in Table 1.

Table 1: Pre-matriculation interests of graduates, persisters, and leavers

Pre-matriculation interest	Leavers	Persisters	Graduates	Total
Pre IT	51 (60.0)	14 (16.5)	20 (23.5)	85 (100)
Pre Biological Science	14 (58.3)	7 (29.2)	3 (12.5)	24 (100)
Pre-Architecture	9 (45.0)	7 (35.0)	4 (20.0)	20 (100)
Pre Medicine	10 (55.6)	5 (27.7)	3 (16.7)	18 (100)
Pre Health Science	6 (66.7)	2 (22.2)	1 (11.1)	9 (100)
Pre Nursing	7 (53.8)	2 (15.4)	4 (30.8)	13 (100)
Pre Dentistry	3 (50.0)	1 (16.7)	2 (33.3)	6 (100)
Pre Pharmacy	2 (66.7)	1(33.3)	0	3 (100)
Pre Veterinary Science	2 (100)	0	0	2 (100)
Total	104	39	37	180

Of the 180 students who met the selection criteria, there were 68 females (37.8%), 109 males (60.6%), and 3 with gender unknown (1.7%). The sample included 103 Caucasians

(57.2%), 39 Asians (21.7%), 21 Blacks (11.7%), 5 Hispanics (2.8%), 3 American Indians (1.7%), and 9 other or of unknown ethnicity (5.0%). The vast majority were native citizens (N=154, 85.6%), a few were either naturalized citizens (N=2, 1.1%) or temporary or permanent aliens (N=19, 10.6%), and for the rest citizenship was not indicated (N=5, 2.8%). They ranged in age at entrance from 18 to 29-years-old, with a mean of 18.77 years (S.D.=1.36).

Students' ACT test scores and high school ranks were similar to those of the total GC 99 cohort. Composite ACT scores ranged from 11-32 with a mean of 20.5 (SD= 3.9). Their AAR scores ranged from 35-136 with a mean of 92.0 (SD=15.5). High school ranks ranged from 2-96, with a mean of 50.8 (SD=15.6).

By the fall of 2004, 37 (20.5%) students in our sample had graduated, 39 (21.7%) were persisting and 104 (57.8%) had left the University. Overall, 96 (53.3%) students transferred out of GC to another college at the University, while 84 (46.7%) left before transfer or had not yet achieved transfer. Only 26 (25.0%) of the students categorized as leavers had achieved transfer by fall 2004, while 33 (84.7%) of the persisters and all of the graduates had transferred. The colleges that students transferred into are shown in Table 2.

Table 2: Colleges where graduates, persisters, and leavers transferred

Transfer College	Leavers	Persisters	Graduates	Total
Liberal Arts	19	15	12	46
Institute of Technology	2	5	6	13
Biological Sciences	0	2	4	6
Architecture & Landscape Architecture	0	1	4	5
Agriculture, Food, and Environmental Science	0	1	4	5
Nursing	0	1	3	4
School of Dentistry	2	2	0	4
Education and Human Development	0	2	1	3
Natural Resources	1	2	0	3
Continuing Education	1	0	2	3
Human Ecology	0	1	1	2
Science and Engineering U of MN Duluth	1	0	0	1
U of M Crookston	0	1	0	1
Total	26	33	37	96

We assessed whether or not graduates, persisters and leavers had remained in a STEM major during their tenure at the University. The numbers and percentages of students remaining in STEM majors are listed in Table 3. Those students who graduated had a variety of majors at graduation including: 22 (59.5%) in STEM majors and 15 (40.5%) in non-STEM majors. The majors of all graduates are listed in Appendix A.

Table 3: Frequencies and percentages of students who remained in STEM majors.

Last Recorded Major	Leavers	Persisters	Graduates
STEM	88 (84.6)	17 (43.6)	22 (59.5)
Non-STEM	16 (15.4)	22 (56.4)	15 (40.5)
Total	104 (100)	39 (100)	37 (100)

We also assessed if leavers had attended other academic institutions after leaving the University. A search of the National Student Clearinghouse data revealed that 35 (34.0%) of the 104 leavers had records indicating enrollment at another institution. Of these students who continued to pursue post-secondary education, 14 (13.6%) subsequently attended a 4-year school and 21 (20.4%) attended a community college. Nine students (8.7%) attended more than one institution after leaving the University of Minnesota.

Student Status

The last recorded student status on the transcripts demonstrated that most persisters had attained senior (N=28, 71.7%) status, while some were either juniors (N= 4, 10.3 %) or sophomores (N=4, 10.3%). Leavers, however, often left as freshman (N=60, 57.5%) or sophomores (N=25, 24.0%), and a small number reached junior (N=15, 14.4%) or senior status (N=4, 3.9%).

GPA

The cumulative GPAs during the last semester of official enrollment were analyzed. For graduates, this indicated GPA at graduation, for persisters this indicated GPA as of Fall 2004 and for leavers this indicated GPA during the last term of enrollment. The majority of the leavers were having academic difficulties at the time of departure from the University. Over half of the

leavers (N=56, 53.6%) had cumulative GPAs below 2.0. This contrasts with the persister group where only a small percentage (N=3, 7.7%) had cumulative GPAs below 2.0. In accordance with University graduation requirements, all graduates had GPAs above 2.0. We did not assess whether or not individual term GPAs ever fell below 2.0 at any time during tenure at the University, however, this might be an area for future research since low GPAs trigger suspension and probation.

For the 96 students who had transferred, we also examined the cumulative GPA during their last term in GC prior to transfer. Leavers had a mean transfer GPA of 2.8 (SD=. 60), persisters had a mean transfer GPA of 2.8, (S.D=. 48) and graduates had a mean transfer GPA of 3.0 (S.D.=. 42). An ANOVA was conducted to test differences in means across groups. The overall ANOVA was not significant which indicates no significant group differences in cumulative GPA at transfer.

ACT scores

We also examined the ACT subscale scores and composite scores for the three subgroups of students. The mean scores are reported in Table 4. A one-way ANOVA was used to compare group means on the subtest and composite scores. It revealed that there were significant differences between groups in the mean ACT reading scores ($F=3.24, p<. 05$) and the ACT science reasoning ($F=3.45, p<. 05$) scores. Post hoc analyses did not find any significant contrasts between specific groups. Based on the means, the results suggest that the persisters generally have lower mean scores than leavers and graduates, however, this may not be a statistically robust finding. It is also important to note that the leaver group is significantly larger than the other two groups.

Table 4: Means and standard deviations (in parentheses) of ACT scores by subgroup.

ACT score	Leavers	Persisters	Graduates
English subtest	18.6 (5.2)	17.5 (3.9)	19.3 (3.9)
Math subtest	20.9 (4.8)	20.6 (4.5)	22.2 (4.4)
Reading subtest	20.7 (5.6)	18.5 (4.8)	21.4 (5.3)
Science reasoning subtest	21.6 (5.1)	19.6 (3.1)	22.0 (3.7)
Composite score	20.6 (4.6)	19.1 (3.2)	21.3 (3.7)

Academic Record Information

Information about the academic patterns that characterized the graduates, persisters, and leavers is presented in Tables 5-13. Information on total number of withdrawals, total number of failed courses, total number of terms not enrolled, and a comparison of student performance in GC and non-GC courses is included.

Withdrawals

Withdrawals were counted on each student's transcript and totals are listed in Table 5. Number of total withdrawals ranged from 0-18. The median number of withdrawals was 1 for leavers, 2 for persisters, and 1 for graduates. As shown in Table 5, the majority of all groups had withdrawn from at least one course during their tenure at the University.

Table 5: Withdrawals: Frequencies and percentages of students in each group

Frequency	Leavers	Persisters	Graduates
0	29 (27.8)	5 (12.5)	18 (48.6)
1	27 (26.0)	10 (25.6)	10 (27.1)
2	22 (21.2)	6 (15.4)	3 (8.1)
3	9 (8.7)	6 (15.4)	3 (8.1)
4	8 (7.7)	3 (7.7)	0
5	4 (3.8)	5 (12.8)	2 (5.4)
6	0	1 (2.6)	0
7	2 (1.9)	0	0
8	1 (1.0)	0	1 (2.7)
9	2 (1.9)	1 (2.6)	0
10	0	1 (2.6)	0
11	0	0	0
12	0	0	0
18	0	1 (2.6)	0
Totals	104 (100)	39 (100)	37 (100)

Terms Gone

We assessed the frequency of terms gone in our sample. Any fall or spring semester was designated as being a term gone if a student did not enroll in any course or withdrew from all courses. The total frequency of terms gone for each student and percentages (in parentheses) are reported in Table 6. As can be seen in the table, the range for all groups was 0-7 with persisters being the most likely to have terms gone. The median number of terms gone, however, was zero for all subgroups, which indicates that this was not a highly prevalent occurrence in this sample perhaps because many leavers left as freshman.

Table 6: Terms gone: Frequencies and percentages of students in each group

Frequency	Leavers	Persisters	Graduates
0	94 (90.4)	25 (64.1)	36 (97.3)
1	9 (8.8)	6 (15.4)	0
2	1 (1.0)	2 (5.1)	0
3	0	2 (5.1)	1 (2.7)
4	0	3 (7.7)	0
5	0	0	0
6	0	0	0
7	0	1 (2.6)	0
Totals	104 (100)	39 (100)	37 (100)

Repeated Courses

It is clear from the transcripts that some students enroll in the same course several times. Since this repetition of courses may contribute to slowing down the process toward graduation and indicate academic difficulty, we coded repeated courses into two categories. Successful repeats were defined as taking the course with an initial grade of D, F, N or W and upon repeating the course, receiving a C- or higher or S. Unsuccessful repeats were defined as receiving an initial grade of D, F, N or W and getting a D, F, N or W upon repeating the course. If a student attempted multiple repetitions of a course, each attempt was counted as a repeat. The successful repeats and unsuccessful repeats are listed in Tables 7 and 8 respectively. Successful repeats ranged from 0-4 while unsuccessful repeats ranged from 0-12. The median number of successful and unsuccessful repeats was zero for all subgroups.

Table 7: Successful Repeats: Frequencies and percentages of students in each group

Frequency	Leavers	Persisters	Graduates
0	91 (87.5)	30 (76.9)	27(73.0)
1	9 (8.6)	3 (7.6)	8 (21.6)
2	3 (2.9)	4 (10.3)	2 (5.4)
3	1 (1.0)	1 (2.6)	0
4	0	1 (2.6)	0
Totals	104 (100)	39 (100)	37 (100)

Table 8: Unsuccessful Repeats: Frequencies and percentages of students in each group

Frequency	Leavers	Persisters	Graduates
0	81 (77.9)	25 (64.1)	35 (94.6)
1	18 (17.3)	8 (20.5)	1 (2.7)
2	3 (2.9)	0	0
3	2 (1.9)	4 (10.2)	1 (2.7)
4	0	0	0
5	0	0	0
6	0	0	0
7	0	0	0
8	0	1 (2.6)	0
9	0	0	0
10	0	0	0
11	0	0	0
12	0	1 (2.6)	0
Totals	104 (100)	39 (100)	37 (100)

Total Failed Courses

The total number of failed courses for each subgroup, with percentages in parentheses, is reported in Table 9. Failed courses included all F's on transcripts, including those courses that were repeated multiple times. No Credit (i.e., N) designations were also included as a failed course. As can be seen in Table 9, frequency of Fs ranged from 0-16, with leavers and persisters having a higher percentage of individuals who failed at least one course than graduates. Median number of failed courses was 2 for leavers, 3 for persisters, and 0 for graduates.

Table 9: Total Failures: Frequencies and percentages of students in each group

Frequency	Leavers	Persisters	Graduates
0	25 (24.0)	10 (25.6)	31(83.8)
1	24 (23.1)	5 (12.8)	3 (8.1)
2	15 (14.4)	4 (10.3)	3 (8.1)
3	13 (12.5)	6 (15.4)	0
4	10 (9.6)	7 (17.9)	0
5	2 (1.9)	2 (5.1)	0
6	7 (6.7)	1 (2.6)	0
7	3 (2.9)	1 (2.6)	0
8	2 (1.9)	1 (2.6)	0
9	2 (1.9)	1 (2.6)	0
10	0	0	0
11	0	1 (2.6)	0
12	0	0	0
13	0	0	0
14	0	0	0
15	0	0	0
16	1 (1.1)	0	0
Totals	104 (100)	39 (100)	37 (100)

Failed GC and Non-GC Courses

To further explore the patterns of failure across the three subgroups of students, we categorized the total failures into those received in GC courses and those received in non-GC courses. The frequencies and percentages of failed GC courses are listed in Table 10 and the frequencies and percentages of failed non-GC courses are listed in Table 11. As can be seen in the two tables, the range of F's in GC courses was 0-7, while the range was much wider in non-GC courses, 0-12. Persisters and leavers had a higher percentage of Fs in GC courses than graduates. Table 10 shows that unlike graduates, who had relatively few F's outside of GC, the majority of both leavers and persisters earn 1 or more F's in non-GC courses. The median number of Fs in GC courses was 0 for all subgroups. The median number of Fs in non-GC courses was 1 for leavers, 2 for persisters, and 0 for graduates.

Table 10: Failed GC Courses: Frequencies and percentages of students in each group

Frequency	Leavers	Persisters	Graduates
0	53 (51.0)	33 (84.6)	35 (94.6)
1	27 (26.0)	4 (10.3)	2 (5.4)
2	10 (9.6)	0	0
3	5 (4.8)	2 (5.1)	0
4	4 (3.8)	0	0
5	2 (1.9)	0	0
6	1 (1.0)	0	0
7	2 (1.9)	0	0
Totals	104 (100)	39 (100)	37 (100)

Table 11: Failed Non-GC Courses: Frequencies and percentages of students in each group

Frequency	Leavers	Persisters	Graduates
0	46 (44.2)	10 (25.6)	31 (83.8)
1	24 (23.1)	7 (17.8)	5 (13.5)
2	15 (14.4)	3 (7.7)	1 (2.7)
3	5 (4.8)	6 (15.4)	0
4	6 (5.8)	6 (15.4)	0
5	2 (1.9)	3 (7.7)	0
6	2 (1.9)	0	0
7	1 (1.0)	0	0
8	2 (1.9)	1 (2.6)	0
9	1 (1.0)	1 (2.6)	0
10	0	0	0
11	0	1 (2.6)	0
12	0	1 (2.6)	0
Totals	104 (100)	39 (100)	37 (100)

Categories of Failed courses

Since 63.3% (N=114) of students in our sample failed at least one course, we categorized each student by type of failure. Based on a pilot study, several mutually exclusive categories were developed. Those students who failed one or more courses were placed into one of the following categories that described the courses they failed. There were three categories of students who only had failures during their first year: 1) Only in GC during year 1; 2) Non-GC courses during year 1; and 3) Both GC and non-GC during year 1. In addition, there were four categories of students who had failures beyond their first year: 4) only in GC after year 1; 5) GC

in year one and later failures in either GC & non-GC; 6) Non-GC after year 1; and 7) both GC & non-GC after year 1. Table 12 contains the frequencies and percentages of the three subgroups of student who fell into the categories of Fs described above. As shown in the table, the highest proportion of Fs for leavers and persisters occurred in non-GC courses taken after year 1.

As can be seen in Table 12, there were 25 leavers who did not fail any courses. Further inspection of these students' transcripts, revealed that 12 of these students never received any grades at the University, and, thus, might have initially registered but withdrew before the end of the 2nd week of their first term. In addition, 2 of the leavers who did not fail any courses were having academic difficulty as indicated by a GPA below 2.0. Finally, 12 of the leavers who never failed a course had no apparent academic problems (i.e., no failures and a GPA above 2.0), which suggests they left the University for reasons other than academic difficulties. A search of the National Student Clearinghouse data found evidence that 5 of the 25 leavers who did not fail a course while attending the University subsequently enrolled in another academic institution.

Table 12: Categories of Failed Courses: Frequencies and percentages of students in each group

F's	Leavers	Persisters	Graduates
GC year 1 & later	12 (11.4)	2(5.1)	0
GC in year 1 only	16 (15.5)	1 (2.6)	0
GC after year 1 only	6 (5.8)	0	0
Non-GC in year 1	10 (9.6)	3 (7.8)	0
Non-GC after year 1	18 (17.3)	19 (48.7)	2 (5.4)
Both after year 1	8 (7.7)	3 (7.8)	3 (8.1)
Both during year 1	9 (8.7)	0	0
No Failed courses	25 (24.0)	11 (18.0)	32 (86.5)
Totals	104 (100)	39 (100)	37 (100)

Specific Failed Courses

Since there were failed courses in all three subgroups of students, we looked more specifically at the individual courses failed to assess whether we could identify any "barrier" courses (i.e., courses that had high rates of failure). In order to determine whether or not there

were patterns in the courses that students failed, we analyzed all the failed courses by group of student (e.g., graduate) and their pre-matriculation interests. A full list of failed courses is listed in Appendix B. Results of this analysis highlighted several math and science courses as problematic for this group of students including GC 0721, Math 1031 and 1271, and Chemistry 1021 and 1022. In addition, we summarized the failed courses in GC math and non-GC math and science courses in Table 13. These findings suggest that leavers and persisters are having substantially more academic difficulty in the lower division math and science courses than are the graduates. Since many math and science courses are prerequisites for STEM majors, these courses appear to be a barrier to successful progress in intended majors for many GC students. In all 3 subgroups, students failed more math courses than science courses.

Table 13: Specific Failed Courses: Frequencies and percentages of students in each group

Types of failed courses	Leavers	Persisters	Graduates
0XXX-level GC Math	26	1	0
1XXX-level Math	41	17	6
1XXX-level Biology	8	6	0
1XXX-level Chemistry	11	6	0
Totals	86	30	6

In addition to problems in STEM courses, leavers appear to have a higher failure rate in GC courses in general. Leavers had 80 failures in GC 1XXX-level courses, while persisters had 8 failures, and graduates had 2 failures in these courses. This suggests that the leavers are having substantial difficulty with the GC curriculum. However, it is important to emphasize that there are significant differences in group sizes, with leavers being a much larger group than the other groups.

Math Pathways

In addition to studying the individual courses that students failed, we also assessed the specific sequences of math courses that students took, based upon the math pre-requisites needed to get into Math 1271. We specified three main math course sequences, called math pathways. The first pathway consists of GC731/732, Math 1051, Math 1151, and Math 1271. The second pathway consists of GC 731/732, Math 1031, Math 1142, and Math 1271. The third pathway consists of GC 731/732, Math 1155 and Math 1271. Although most students seemed to be taking one of these paths, the start and stop points are different for many individuals such that some students took only one or two courses in a specified path. For instance, 26 (25.0%) leavers took only GC 731 or GC 732. Similarly, 9 (24.3%) graduates took only Math 1271. A complete list of students' grades in each math pathway is included in Appendix C.

Discussion

This study allowed us to assess the academic patterns of the 1999 GC cohort who indicated a pre-matriculation interest in STEM majors. Several important findings emerged. First, over half of the sample, 57.8% (N=104) left the University, while only 20.5% (N=37) had graduated by Fall 2004. In addition, only a small minority of the leavers attended another academic institution by Fall 2004. Thus, the low graduation rate cannot fully be explained by students successfully transferring to other schools. In addition, only 53.3% of the sample transferred from GC to another college within the University. Although 25% of the leavers and 84.7% of the persisters transferred out of GC, these students were either having difficulty in the GC curriculum or the courses that are prerequisites for their intended major. The low transfer and graduation rates into STEM majors is similar to the findings of previous research within ORE (Wambach et al., 2003).

Even among students who successfully transferred and graduated, many students did not end up pursuing a STEM degree. Fifty-four percent of the graduates earned a degree in a STEM major. In addition, the most common transfer destination for all three student subgroups was CLA. Leavers were more likely than graduates or persisters to remain focused on a STEM major. This may indicate a resistance to changing to a different degree path despite having academic difficulties in courses needed to pursue STEM majors. The finding might also, however, reflect the fact that most leavers left within their first year of attendance, which did not provide much time for changing major interests.

The academic records of this sample revealed several patterns in ACT scores and GPAs. First, there is some evidence suggesting there are group differences in math and science reasoning ACT scores, with persisters having lower scores than the other groups. Although, provocative, this finding needs to be further explored and substantiated before it can be interpreted. Also, GPA data revealed that although the majority of leavers had a GPA under 2.0, some had no apparent academic difficulties. Further research into why these students leave may assist with understanding the challenges that GC students with STEM majors face. It is important to note, however, that among the students who achieved transfer, there were no differences between groups for mean cumulative GPA at transfer (i.e., approximately 2.8). This relatively high GPA may provide a buffer from academic probation for students who fail courses after transfer.

There were several areas of academic difficulty in this sample. Many leavers and persisters had high failure rates in both GC and non-GC math and science courses. Graduates seemed to have fewer academic difficulties across the board. This might indicate that these students had less difficulties with the coursework required for the STEM majors, but might also

reflect their tendency to change majors earlier in their academic career than persisters or leavers. Persisters were most likely to continue with a STEM major interest despite repeated failures in prerequisite math and science courses.

Assessing math achievement more specifically, there is much variation in the math pathways taken by students interested in STEM majors. The vast majority of leavers had academic difficulties in math courses, and many leavers only took a GC 0XXX-level math course and never progressed to taking a non-GC math course. Although some persisters and leavers took more than one math course, only 8.7% (N=9) of leavers and 23.1% (N=9) of persisters passed Math 1271, which is a prerequisite course for many STEM majors. This suggests that math is a major barrier to getting STEM degrees. Among graduates, 48.6% (N=18) passed Math 1271 and only 4 of those that passed Math 1271 did not receive a degree in a STEM major. The math pathway data also provides evidence that 21.6% (N=8) of the graduates were able to pass 1271 successfully without taking prior University math courses, while other graduates had difficulties in the various math pathways. This suggests that although the majority of GC students with STEM interests have significant difficulties in math, some GC students succeed in college calculus, without taking other math courses at the University. It is these students who succeed in college calculus that are likely to earn degrees in STEM disciplines. This supports further investigation of high school transcripts to attempt to identify math curriculums that prepare students to successfully enter the University math curriculum.

Overall, the large number of students who intended to pursue STEM majors but ended up leaving the University is alarming. Over half of the GC students who have pre-matriculation interests in STEM majors ultimately leave and roughly half of those who graduate do so in non-STEM majors. This suggests that students are encountering significant barriers in their pursuit

of these majors. The findings of this study suggest that one barrier to pursuing STEM majors is math courses in general and Math 1271 in particular.

In addition to academic difficulties in math and science courses, leavers and persisters seem to have many failures across the curriculum both in GC and non-GC courses. Leavers had particular difficulty with the GC curriculum. The majority of leavers had failed at least one course, even though leavers were likely to leave the University as freshmen. Persisters who pursue STEM majors have high percentages of repeats and are less likely than graduates to change into non-STEM majors. This suggests that persisters might not be graduating because they are spending time repeating required courses or trying to transfer into a major where they do not have the necessary academic background for success.

The results of this study suggest that GC students who intend to pursue STEM majors and are not prepared to take Math 1271 may need more intensive math preparation prior to attempting Math 1271. Perhaps, one way to address this issue is to restructure the math curriculum for students who are not ready to take calculus upon entrance into the University. These students may benefit from an alternative curriculum that would include additional intensive math preparation or supplemental instruction options.

It is important to note, however, that there were a significant number of students in this sample who had academic difficulty with a wide variety of GC courses including, but not limited to math courses. Perhaps students who had difficulties in GC math and science courses could use more career counseling to help them select majors suited to both their interests and academic preparation.

This research also suggests that students' career interests be considered in the admissions process. While some students from the second or third quartiles of the high school class (HSRs

between 25 and 75) may be able to complete degrees in STEM majors, it may be that the amount of additional preparation they require to be successful in these majors is a daunting obstacle to timely degree completion. Requiring less well qualified students to commit to an intense STEM preparation program as a condition of admission might ensure that only highly motivated students from this group attempt these majors. Students who are less committed to STEM majors could be encouraged to make a different choice at matriculation. This could potentially reduce the problem of long-term, unsuccessful persistence in STEM programs.

In summary, the findings from this study highlight the academic difficulties that are faced by many GC students who have pre-matriculation interests in the STEM majors. In the 1999 GC cohort, these students had low transfer and graduation rates and high rates of leaving the University, failing courses, and repeating courses multiple times. The findings of the study demonstrate the difficulties many of these students encounter in math and science courses in GC and after transfer. This suggests that the U of MN needs to re-evaluate how to best serve under qualified students who are interested in pursuing STEM majors.

Appendix A:**Majors of Graduates of 1999 GC cohort with STEM interests**

Major	Frequency
Animal Science*	1
Architecture*	3
Biology*	1
Child Psychology	1
Communication	1
Computer Science*	4
Design	1
Economics	2
Electrical Engineering*	2
Gene/Cell Biology*	1
Inter College Program	2
Kinesiology	1
Math *	1
Mechanical Engineering*	1
Microbiology*	1
Neuroscience*	2
Nursing*	3
Nutrition*	2
Political Science	1
Psychology	1
Science/Tech Communication	2
Sociology	1
Soc/Law/Criminology/Deviance	2
Total	37

Note: Asterisks indicate majors counted as STEM

Appendix B:
Failed Courses

Letters in parentheses indicates the initial intended major interest of the students who failed each course

A = Pre-architecture
 B = Pre-biological science
 D = Pre-dentistry
 H = Pre-health science
 M = Pre-medicine
 N = Pre-nursing
 P = Pre-pharmacy
 V = Pre-veterinary science

GC	Leavers	Persisters	Graduates
712	1 (M)		
717	1 (M)		
721	6 (N, H,I,A,B=2)	1 (N)	
731	16 (I=8,B=2,V,D,A,M=3)		
732	2 (H, B)		
1076			1 (N)
1082	2(B=2)		
1086	1 (M)		
1112W	1 (I)		
1131	5 (M, B, I=3)	2 (H, I)	1 (I)
1135	3 (N, B, I)		
1163	1 (I)	1 (I)	
1166	2 (N,I)		
1211	4 (P, I=3)		
1222	1 (M)		
1231	1 (N)	2 (I, N)	
1233	2 (H, I)		
1235	1 (M)	1 (I)	
1251	2 (M, N)		
1281	4 (M=2,B D, A)	1 (I)	
1285	2 (D, N)		
1311	1 (I)		
1365	4 (A, I=2, B)	1 (A)	
1367	2 (I=2)		
1371	5 (M=2, A, B, I)		
1374	1 (B)		
1421	14 (I=4, B,M=5, D, N, A=2)		
1422	5 (I=5)		
1454	5(B,M, H, A, I)		

		1 (D)		
		Leavers	Persisters	Graduates
	1456	1 (D)		
	1461	1 (N)		
	1464	1 (B)		
	1511	2 (B, I)		
	1513	2 (I, A)		
	1571	1 (I)		
	1851	3 (M=2, I)		
Math	1001	1 (I)		
	1031	6 (I=2, H, M, N, A)	1(I)	
	1051	3 (I=3)	5 (B ,A, H, I=2)	2 (N, I)
	1422	1 (M)		
	1142	2 (M, I)	2 (2=A)	
	1151	4 (B=2, I=2)	4 (I=2, H, B)	1 (N)
	1155	5 (I=4, M)	1 (I)	
	1271	12 (P, I=11)	2 (I,M)	3(N=3)
	1272	7 (I=7)	2 (M, I)	
	2243	1 (B)	1 (I)	1 (I)
Stat	1001		1 (M)	
	3001	1 (I)		
SCIENCES				
Bio	1001	5 (I=3, A=2)	2 (I=2)	
	1002W		1 (M)	
	1009	3(B=2, I)	3 (N, M,H)	
Chem	1011	1 (I)	3(I=2, M)	
	1021	4 (M=2, I=2)	2 (M,B)	
	1022	6 (I=5, M)	1 (I)	
	2301		1 (M)	
	2302		1 (M)	
Phys	1131W	1 (M)		
	1201W		1 (M)	
	1301	3 (I=3)	1 (I)	
	1302	2 (I=2)		
Pmed	1002	1 (M)		
	<i>(Physical Med and Rehab)</i>			
PubH	3091		1 (I)	

(Public Health)

	Leavers	Persisters	Graduates
INMD 3001	1 (N)	2 (M=2)	
INMD 3002		2 (M=2)	

(Interdisciplinary Medicine)

PHAR 5201	1 (N)		
PHSL 3051	1 (N)		
EE 2011	1 (B)		
3102		1 (I)	
3015			1 (I)
4541		1 (I)	
AEM 4301		1 (I) (Aerospace engineering)	
CSCI 1103		1(I) (Computer Sci)	
1113	2(I=2)		
1901		2 (N, I)	

Business

Econ 1101	3 (I=3)	1 (H)	
3101	1 (M)		
3960	1 (M)		
4171	1 (M)		
4431W	1 (M)		
Fina 3001	1 (M)		
OMS 1550	1 (A)		
2250		1 (H)	
APEC 1102	1 (B)		(applied econ)
3002		1 (A)	
3007		1 (A)	
BIE 5011		1 (H) (Business and Ind. Ed)	
HRD 5301		1 (H) (human resource dev)	

Liberal Arts

AST 1001	1 (H)	1 (I) (American Studies)	
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			Persisters	Graduates
	4101W	1 (H)		
	Leavers			
Anth	1005W	2 (I=2)	1 (H)	
Arch	1301	3(I=2, A)		
	4511		1(A)	
	5284		1 (A)	
	5501		1 (A)	
Kin	1871	1(A)		
	1989	1 (I)		
	3112		1 (M)	
	5141		1 (A)	
Urbs	3301W		1 (A)	(Urban Studies)
EAS	3462	1 (I)		(East Asian Studies)
Geo	1001	2 (M, I)		
	1502		1(A)	
	3101	1 (A)		
	3111	1 (A)		
	3371		1 (A)	
	3373		1 (A)	
	3381W		1(M)	
Hist	1011W		1(A)	
	1012W	2 (P,H)		
	1017		1 (I)	
	1031		1 (B)	
	1307	1 (M)		
Phil	1001	1 (I)		
	1002W		1 (I)	
	1004W		1 (I)	
CSCL	1401	1 (I)		(cultural studies & comp. lit)
Engl	3004W		1 (H)	
	3005W	1 (V)		
	3006W		1(H)	
	3601W		1 (M)	
	3650	1 (B)		
Spch	1313W	1 (H)		
Comm	3411		1 (H)	
Jour	1001	2 (I=2)		

		Leavers	Persisters	Graduates
Pol	4308	1 (I)		
Soc	1001	2 (H, B)	1 (M)	
	1311	1 (I)		
	3415		1 (B)	
	4102		1 (B)	
	4108		1 (B)	
FSOS	4101		1 (I)	
	4104W	2(H, B)		
	4150	1 (H)		
EPSY	3902W		1 (P)	
Psy	1001	2 (I=2)		
	3005W	1(I)		
	3061		1 (M)	
Cpsy	2301	1 (I)		
	4303	1 (I)		
	4343	1 (I)		
	4994		1 (M)	
CAPY	5633	1 (M)		
CAPY	5638	1 (M)		
	5644	1 (M)		
	5647	1 (M)		
	5653	1 (M)		
DHA	1101W	1 (B)		(design,housing,& apparel)
	1201	2 (B, V)	1 (H)	
FSCN	1112	1 (M)		(food science & nutrition)
ES	1011	1 (B)		(environmental science)
NRES	1201	1 (B)		(natural resources)
	3002	1 (B)		
	3241W	1 (B)		
	4061W	1 (B)		
Mus	1001	1 (M)		
	1260	1 (M)		
Arts	1001W	1 (I)		
	1301		1(A)	
PE	1014	1 (V)		
	1015	1 (I)		

		1 (A)	Leavers	Persisters	Graduates
Lask	1001	3 (I=3)		1(A)	
	1101				
IOFT		1 (I)		(Institute of Tech)	

LANGUAGES

ASL	1702	1 (M)			
CHN	1011			1(A) (Chinese)	
	1015			1(A)	
	3031	1 (M)			
	3900			1 (A)	
Span	1022	1 (I)			
MIL	1011	1 (M)			
LA	3501			1(A)	

**Appendix C:
Math Pathways of 1999 GC cohort with STEM interests**

Courses coded

GC 731/732

Math 1031

Math 1142

Math 1051

Math 1151

Math 1271

Intended Majors (First major recorded on transcript)

A = Pre-architecture

B = Pre-biological science

D = Pre-dentistry

H = Pre-health science

M = Pre-medicine

N = Pre-nursing

P = Pre-pharmacy

V = Pre-veterinary science

Note: Each row represents an individual case, except where there are several individuals with identical pathways, grades and majors (these are indicated by the Ns in parentheses). Multiple grades indicate retakes of the course and Ws indicate withdrawals from the course.

GRADUATES

731/732	1051	1151	1271	Intended Major	Last Recorded Major
A				N	NURSING
A-				I	SOCIOLOGY
B+				N	NURSING
B-				D	CRIMINOLOGY
A			B-	I	NEUROSCIENCE
	A-	A	A	B	NERUOSCIENCE
	A	A	A	I	MECH ENGINEER
B	C-	F,B		N	INTER COLLEGE
B			C	I	NUTRITION
W,B	W			M	NURSING
B	C	D+,C		A	ARCHITECTURE
B-	C+	W	D+C	I	MICROBIOLOGY
B-		D	C	I	SOC/LAW/C/D
	B-	F,C		I	ECONOMICS
C-	W,C	N		I	POL SCIENCE
731/732	1031	1142	1271	Intended Major	Last Recorded Major
		A-		A	ARCHITECTURE
B	A	C		A	ARCHITECTURE
B-		C+		M	NUTRITION
B-	C	W,B	B-	I	COMMUNICATION
C+	C			I	ENV. DSG
D	C-			B	ANI PRO SYN
731/732	1155		1271	Intended Major	Last Recorded Major
A-	C		WC-	D	BIOLOGY
B+				M	CHILD PSY
B+			W,F	I	SCI/T COM
B-	C-			H	PSYCHOLOGY
	B-		F, C	I	ECONOMICS
			1271	Intended Major	Last Recorded Major
			A	I	COMPUTER SCI
			B+	I	ELECTRICAL ENG
			B+	I	ECONOMICS
			B+	I	COMPUTER SCI
			B+	I	MATH
			B+	I	COMPUTER SCI
			B	I	ELECTRICAL ENG
			B	I	COMPUTER SCI
			D, F	N	KINESIOLOGY

PERSISTERS

731/732	1051	1151	1271	INTENDED MAJOR	LAST RECORDED MAJOR
A-				H	KINESIOLOGY
A-				M	KINESIOLOGY
B				M	CHILD PSY
C+				B	DENTAL HYGIENE
C+				M	ENGLISH
D				A	SEC ED
A	A-	C+	C	B	GENE/CELL
A-	B	D,F	W,W,W	I	UNDECIDED
A-	C-			B	FISH/WILDLIFE
B+	C+		C	N	ARCHITECTURE
B	C	B-	W,B	M	BIOLOGICAL SCIENCES
		B		A	ASIAN LANG/LIT
B-	W		W	I	JOURNALISM
B-	C+	W		B	PRENURSING
B-	F			B	SOC/LAW/C/D
C+	F	F		I	UNDECIDED
C+	F,D	W		B	PRE BIO SCI
C+	F			A	APPLIED ECON
C+	F,C-		W,W	I	URB COM
	C-	F,D		I	PRE MED
	D+	C	W,D+,C-	I	BIS
		D	C-	I	CIVIL ENG
		F	W,F,W,W, W,F	I	PRE IT
F	F,D+	W		I	FAMILY SOC SCI
731/732	1031	1142	1271	INTENDED MAJOR	LAST RECORDED MAJOR
B-	W			A	HOTEL RIM
C	C-	W, F, F, I		A	ART
	C+	B	W	A	COMM
C+	F			I	PRE IT
		A		D	DENTAL HYGIENE
731/732	1155		1271	INTENDED MAJOR	LAST RECORDED MAJOR
	A		B+	I	MECH ENG
	C-			I	CINEMA
			A-	I	ELECTRICAL ENG
			C+	I	AERO ENG
			F, C-	M	BIOLOGY

LEAVERS

731/732	1051	1151	1271	INTENDED MAJOR	LAST RECORDED MAJOR
A-				N	NURSING
B				M	PRE MED
B				N	NON DEGREE
B-				M	PRE MED
C+ (N=2)				M	SOCIOLOGY
C				N	NURSING
D				P	PRE PHAR
D				N	NURSING
F, C+				H	PRE SEC ED
F (N=2)				M	PRE MED
F				I	HUM RES DEV
F				D	PRE DENT
F				N	ENG
F				B	BIOLOGICAL SCIENCES
F (N=6)				I	IT
F,F				B	NURSING
F,F				I	IT
W				H	HEALTH SCIENCES
W				I	IT
W,W,C-				A	ARCHITECTURE
A	C-	C-	W	B	BIOLOGY
A		W		M	PRE MED
A-	W			I	IT
A-			W,W	I	IT
A-	A-		F,D	P	UNDECIDED
B+	C	W		V	PRE VET
B+		F,W		I	IT
	B+	C	W,W, F	I	IT
	B	W, A	D	I	IT
B	W			M	PRE MED
B	D+	D+		B	BIOLOGICAL SCIENCES
B	C-	W,W	W	I	IT
B	D,C-	W		I	IT
B	D+	W		I	CHEMISTRY
B-	B	D+	D,B	I	UNDECIDED
B-	F,D	F,C	D	I	CHEMISTRY
B-	W			H	UNDECIDED
B-	W			D	PRE DENT
B-	W			B	BIOLOGICAL

					SCIENCE
731/732	1051	1151	1271	INTENDED MAJOR	LAST RECORDED MAJOR
B-	C-	W		A	ARCHITECTURE
	B-	F,C-	W,C	B	BIOLOGICAL SCIENCES
C+	F, D+			I	IT
C-	F			I	IT
		C+	F	M	ECONOMICS
D+,A-	A	C-	D	I	IT
	F		F	I	IT
F	W			I	IT
W	C-		W	M	PRE MED
731/732	1031	1142	1271	INTENDED MAJOR	LAST RECORDED MAJOR
A-	B-			B	ENV NAT RES
B+	B			I	FRENCH STUDY
B-	F			M	PRE MED
B-	D			B	BIOLGOGIAL SCIENCES
	B			I	IT
C+	D+			I	ENGLISH
C-	D,F			I	TT
		B		A	ARCHITECHTURE
F	F			I	CSCL
731/732	1155		1271	INTENDED MAJOR	LAST RECORDED MAJOR
A-	A-			A	ARCHITECTURE
A-	C		W, F, I	I	GEOLOGY
A-	F			I	IT
B+	C		F	A	ARCHITECHTURE
B	C-		F	I	IT
B	D,W,D			I	IT
B-	C-		F,F	I	POLITICAL SCI
	C		B+	I	IT
C+	W			I	IT
	C		F,W,C	I	IT
C-	C-			A	ARCHITECTURE
	C-		C+	I	IT
	C-		C	I	IT
	D,D		F	I	IT
	F (N=2)			I	IT

731/732	1155		1271	INTENDED MAJOR	LAST RECORDED MAJOR
	F			M	PRE MED
F	F			A	ARCHITECHTURE
			A-	B	PRE DENT
			C	I	IT
			C-	I	COMPUTER SCI
			F	I	IT