STEM COLLABORATIVE CENTER

STEM Collaborative Center Research Briefing

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TITLE: UNM's Murky Middle STEM Student

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CONTENTS

BACKGROUND, RESEARCH QUESTION, & STUDY DESCRIPTION

BACKGROUND INFORMATION: Within higher education we hear a lot about the "achievement gap," as well as retention. The STEM Gateway grant looked at the this via a "Stop, Switch, Stay" study (fig 1.). This study attempts to address the achievement gap from a different perspective. Within university settings, low performing students raise a red flag and receive intervention support, and high performing students gain access to opportunities. However, the students with mediocre GPA after their first year, 2.0 – 2.99 (termed the Murky Middle [MM]), get little attention. This leads to the question of should these "invisible" students be the focus of future retention and intervention efforts.

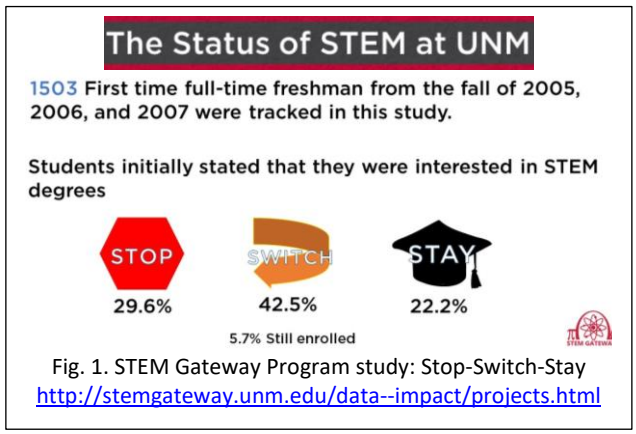


Fig. 1. STEM Gateway Program study: Stop-Switch-Stay
http://stemgateway.unm.edu/data--impact/projects.html

RESEARCH QUESTION(S): Which attribute (demographics, socioeconomic factors, major) acts as the best predictor to Murky Middle (MM) STEM students' long-term performance (persistence) and persistence within the STEM fields?

STUDY DESCRIPTION: The STEM Collaborative Center (STCC) studied 3365 first-time, full-time freshmen students who entered UNM's Main Campus in Fall 2016 through their fourth semester (Spring 2018). STEM majors reflect the 'definition of STEM in Appendix I for 1st major only and include all pre- and general STEM majors.

The data were analyzed in three groups: 1) STEM Majors, 2) non-STEM Majors, and 3) All students (Table 1). Within each of these groups, data was parsed into cohorts based on 1st semester GPA: a) Low (0 – 1.99), b) Murky Middle (2.0 – 2.99), and c) High (≥3.0).

	STEM Majors				non-STEM Majors			
1st sem. GPA	Low	MM	High	All	Low	MM	High	All
# of students	111	229	738	1078	215	454	1618	2287

	STEM Majors (32%)			non-STEM Majors (68%)		
1st sem. GPA	Low	MM	High	Low	MM	High
% of students	10%	21%	68%	9%	20%	71%

A NOTE OF CAUTION: For the following FINDINGS, STEM vs non-STEM and GPA group are only assigned within the 1st semester unless otherwise noted. Thus, these data show the shift in proportions of each GPA group within STEM or non-STEM over time, and does NOT reflect movement across GPA groups or STEM/non-STEM Majors. For instance, in FINDING 6 (pg. 22), for the 41 American Indian STEM Students in their 1st semester, 8 (20%) had Low GPAs, 10 (24%) were within the Murky Middle, and 23 (56%) had High GPAs. By the 4th semester, of the American Indian students who were STEM majors with Low GPAs their 1st semester, only 2 of the 8 remained, accounting for 9% of the remaining American Indian students who initially expressed an interest in STEM.

RETENTION: Students still enrolled at UNM's main campus, but not necessarily within a STEM major.

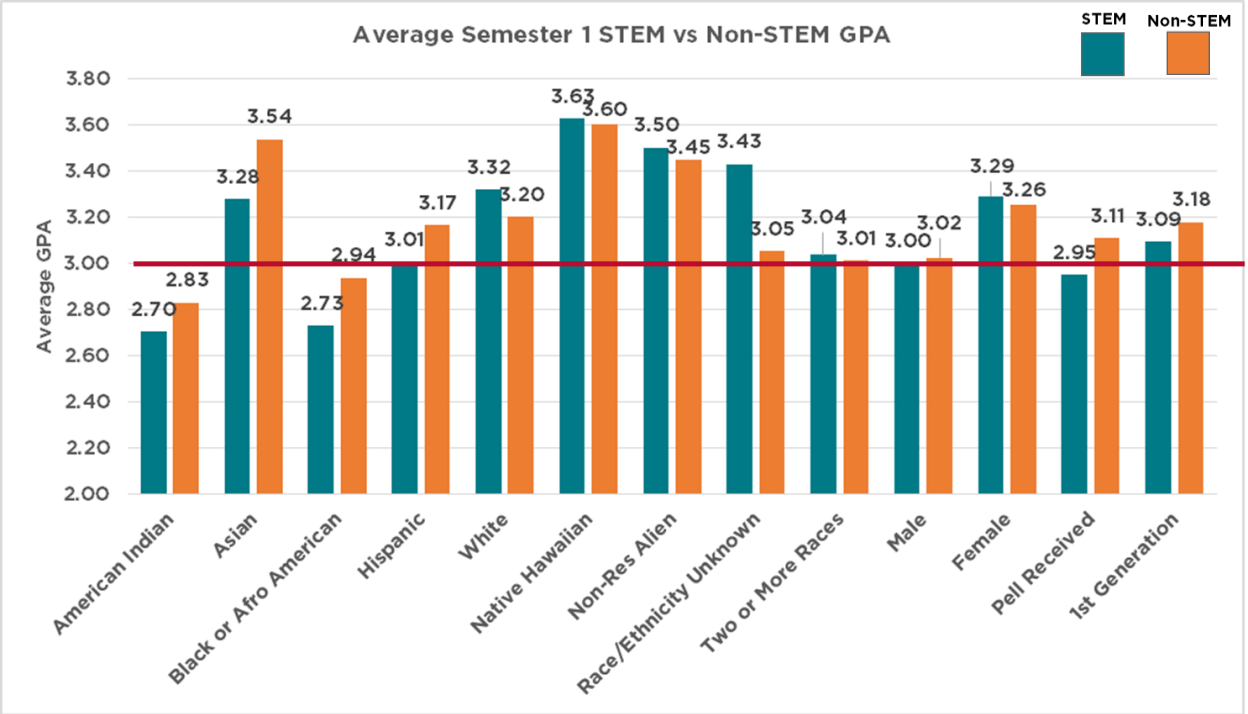
FINDINGS

FINDING 1: FIRST & FOURTH SEMESTER GPAS AND THE MURKY MIDDLE

American Indians and Black or Afro Americans (Black) have an average 1st semester GPA below 3.0 for both STEM and non-STEM Majors, with Pell Received STEM majors also below the 3.0 mark, but non-STEM above it.

The largest discrepancy between STEM and non-STEM are seen with STEM Asian, Black or Afro American and Hispanic, as well as Pell Received, all well below non-STEM. But generally non-STEM outperforms STEM, with the exception of STEM Race or Ethnicity Unknown outperforming non-STEM.

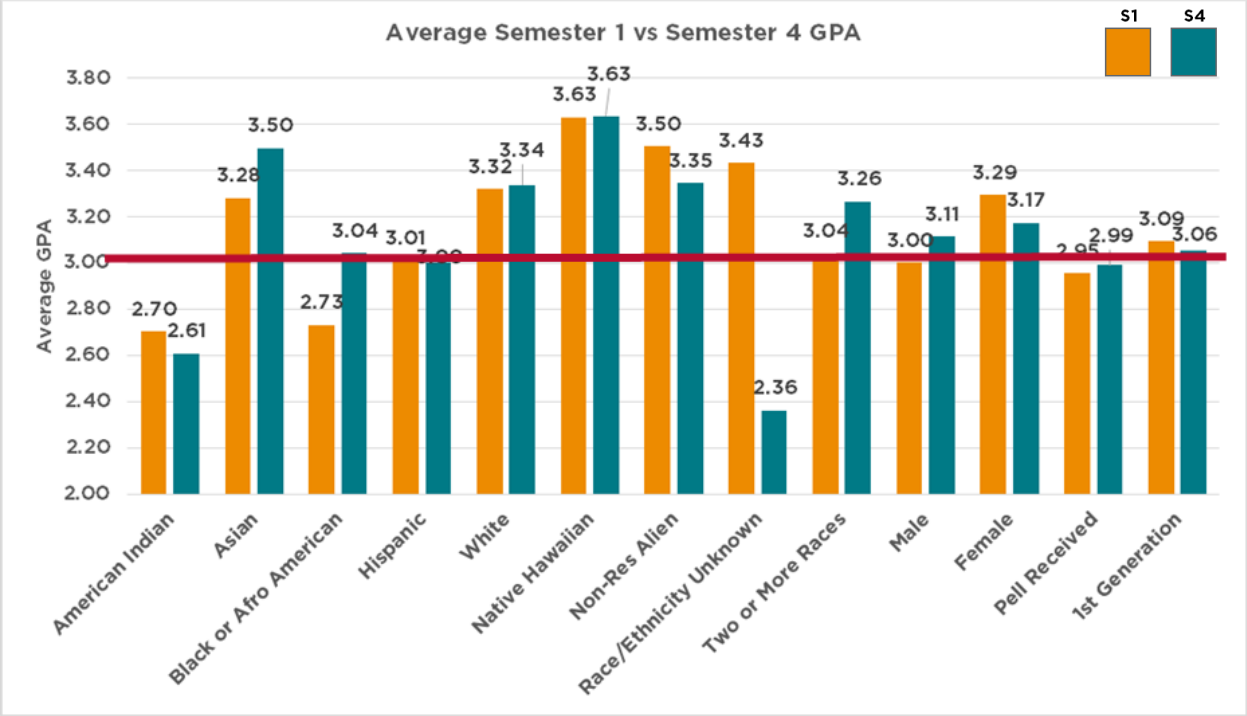
And a last point to note are that males in both STEM and non-STEM are comparable, as are females, but females outperform males after their 1st semester.



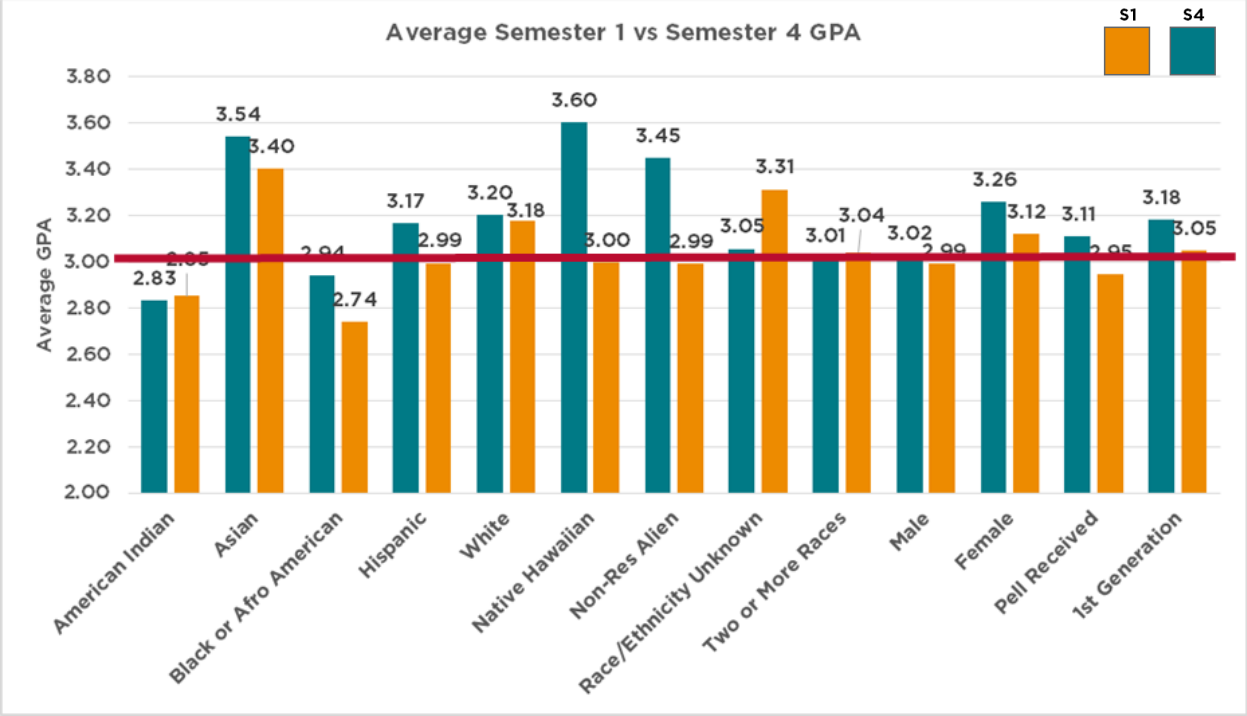
Between Semester 1 STEM vs non-STEM students' average GPA, there is the same general relationship between ethnicities, with Native Hawaiian students with the highest average 1st Semester GPA and American Indian students with the lowest.

Compare this to 4th semester GPA for STEM vs non-STEM students, regardless of their initial semester group. Some groups see an increase in GPA and others see a decrease. But most of the movement is small. With the exception of Black STEM students increase in performance and non-STEM decrease.

STEM

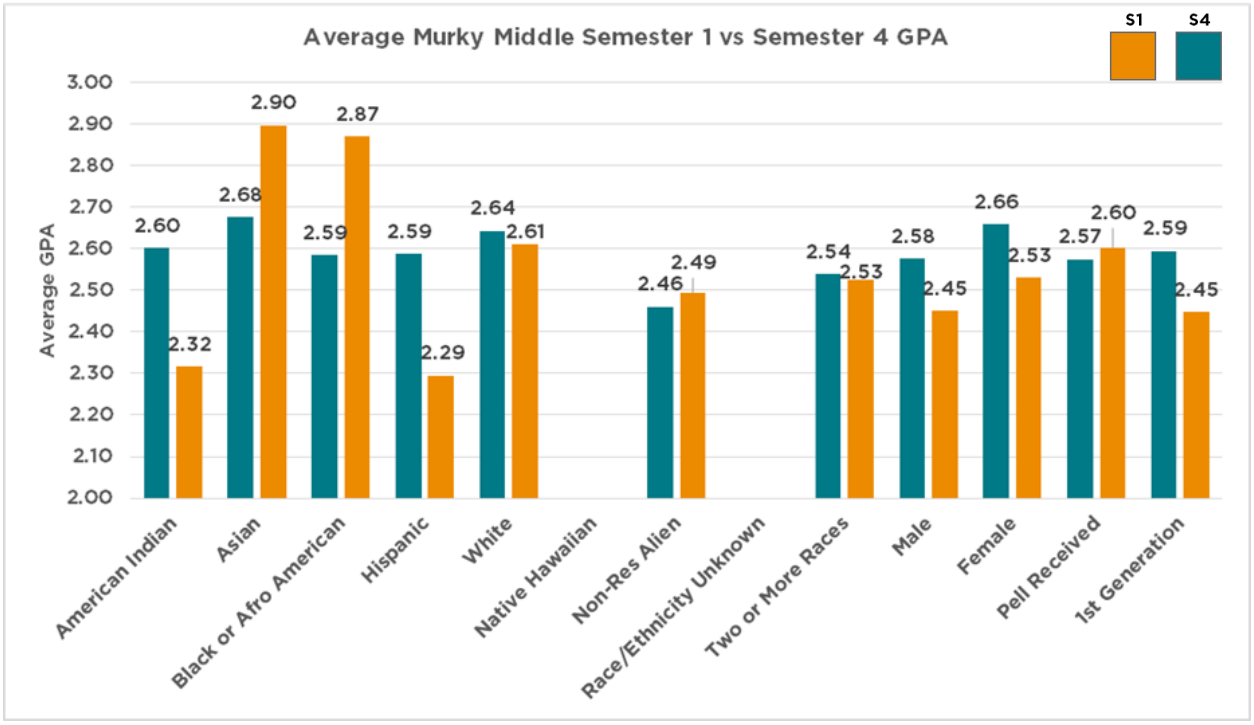


Non-STEM

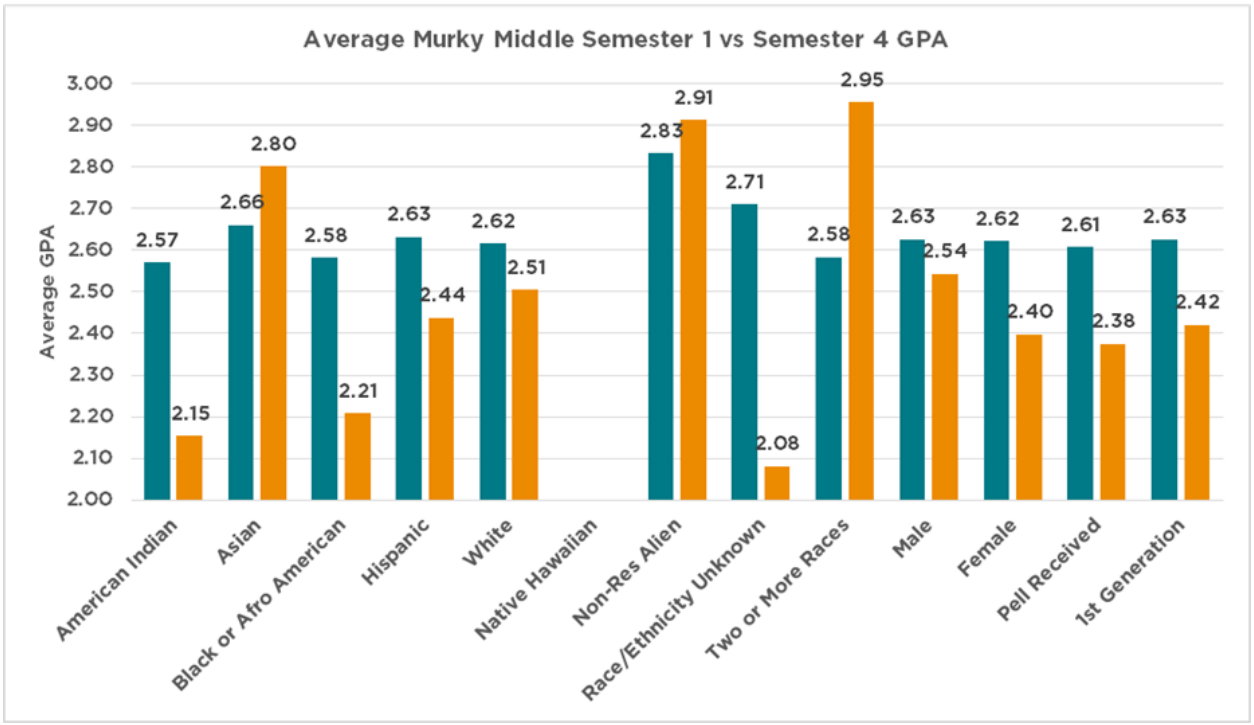


For 1st semester MM students' 1st semester average GPA and 4th semester average GPA, most 1st semester MM students' GPAs declined by the 4th semester, with the exception of Asians, Black STEM students, and most noticeable drops in GPA for American Indian and Hispanic students, as well as Black non-STEM students.

STEM



Non-STEM

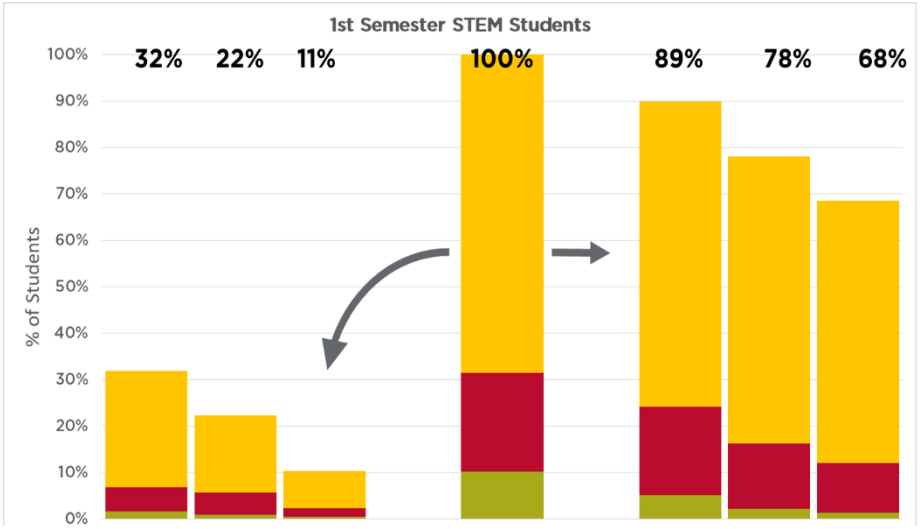


FINDING 2: STEM VS. NON-STEM AND THE MURKY MIDDLE

The following graphs represent the "shift" or "stay" concepts of "Stop. Switch. Stay." For example, from the 1st semester STEM (S1), 100% of the students had STEM majors. And, of those students, 68% were in the High GPA category, 21% MM, and 10% Low. Moving into S2, 11% of all 1st Semester STEM students switched into non-STEM Majors. Within the remaining 89% of STEM students, 65% were initially from the High GPA group, 19% from the MM, and 5% from the Low. Of the 11% who switched to non-STEM majors, 8% were from the High GPA group, 2% from the MM, and 1% from the low. But, each of these values represents about 10% of each GPA group respectively. By the 4th semester, only 68% of students still enrolled remained in a STEM major.

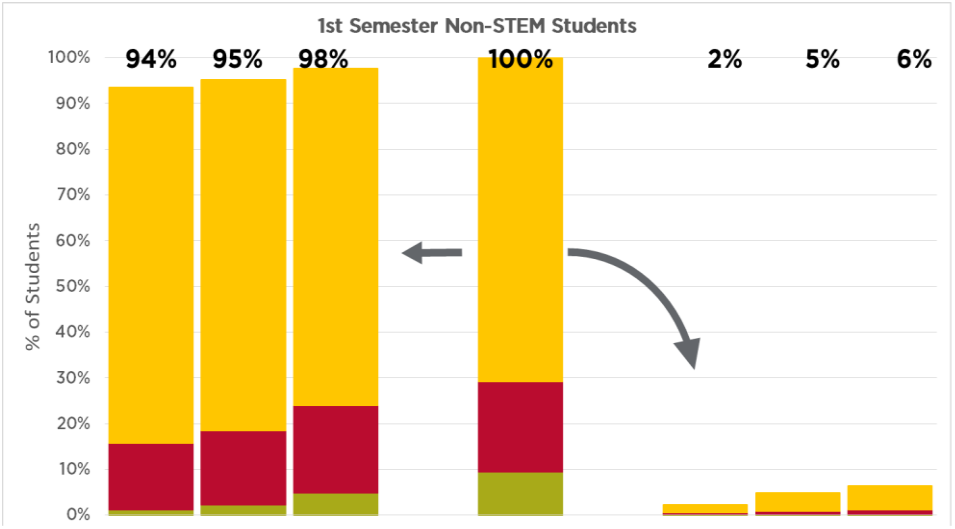
Due to the almost double the student enrollment in non-STEM majors, we would have to see twice as many non-STEM majors switch into STEM fields to see the same type of effect on the % of students shifting majors as the reverse direction. However, even taking this in to account, there is relatively little movement into STEM fields. But, when it does occur, it is more likely from students in either the MM or High 1st Semester GPA groups.

1st Semester STEM Students



	S4	S3 Non-STEM	S2	S1	S2	S3 STEM	S4
High	25%	16%	8%	68%	65%	62%	56%
MM	5%	5%	2%	21%	19%	14%	11%
Low	2%	1%	1%	10%	5%	2%	1%

1st Semester non-STEM Students



	S4	S3 Non-STEM	S2	S1	S2	S3 STEM	S4
High	78%	77%	74%	71%	2%	4%	5%
MM	15%	16%	19%	20%	0%	1%	1%
Low	1%	2%	5%	9%	0%	0%	0%

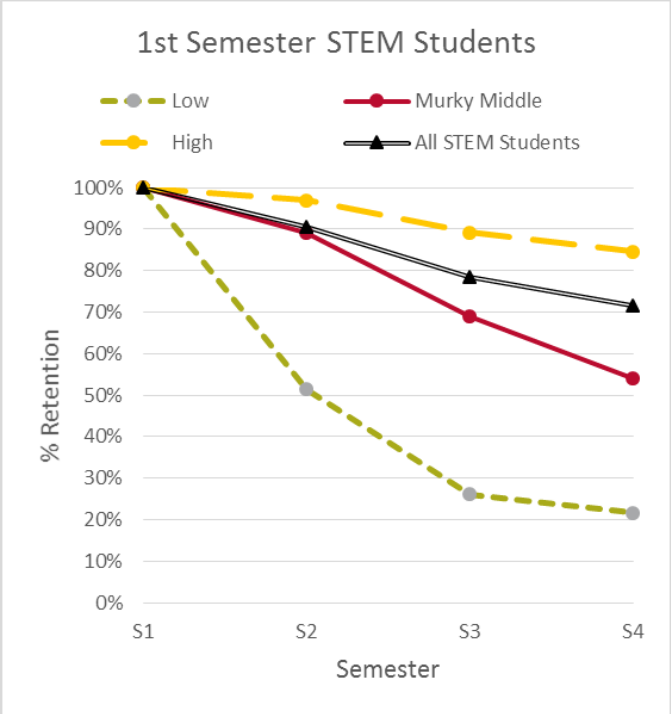
FINDING 3: RETENTION (AT THE UNIVERSITY LEVEL) AND THE MURKY MIDDLE

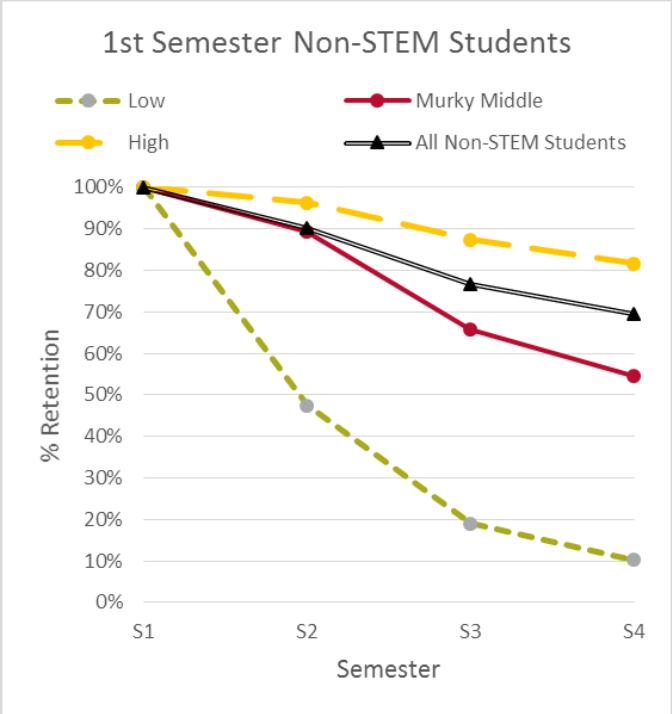
Retention is of the students who were first identified into each group, not where they are by the 4th semester. For example, for the higher retention rates within STEM, that does not reflect retention within STEM, but rather that the 1st Semester STEM student is retained at the university.

There is a larger decline in enrollment for Low GPA non-STEM majors, but otherwise there is little noticeable difference in retention between STEM and non-STEM majors.

The largest drop in enrollment is for Low GPA groups after the 1st semester, where Middle and High GPA groups see the steepest decline after the 2nd semester.

By the 4th semester, only about 15% of Low GPA students are retained, with STEM retention surpassing non-STEM, 55% of MM for both STEM and non-STEM groups, while over 80% of the High GPA students are retained, and a slightly higher retention within STEM in the High GPA category.





FINDING 4: CHOSEN MAJOR AND THE MURKY MIDDLE

1st Semester (Fall 2016)

- (Pre) Biology has 35% of all STEM Majors, followed by Pre Mechanical Engineering with 14% and (Pre) Biochemistry with 11%.
- All Pre-Construction Management and Civil Engineering fell into the Low GPA group.
- All Biochemistry (81% Pre-Biochemistry), Chemical Engineering, Environmental Science, (Pre) Physics (& Astronomy), and Pre-Statistics fell into the High GPA group.
- Pre Nuclear Engineering students were evenly spread across the GPA groups.
- While all other STEM Majors had the majority of the students in the High GPA group, (Pre) Astrophysics, (Pre) Computer Engineering, .(Pre) Computer Science, (Pre) Earth & Planetary Sciences, and (Pre) Nuclear Engineering had MM populations of more than 30%.

	Low (<=1.99)	Murky Middle (2.0-2.99)	High (>=3.0)	**All**
N	111	229	738	**1078**
Major				
Biochemistry	(0%)	(0%)	3 (100%)	**3**
Biology	2 (9%)	1 (5%)	19 (86%)	**22**
Chemical Engineering	(0%)	(0%)	1 (100%)	**1**
Civil Engineering	1 (100%)	(0%)	(0%)	**1**
Environmental Science	(0%)	(0%)	1 (100%)	**1**
Physics	(0%)	(0%)	2 (100%)	**2**
Pre Astrophysics	(0%)	6 (33%)	12 (67%)	**18**
Pre Biochemistry	4 (4%)	17 (15%)	91 (81%)	**112**
Pre Biology	29 (8%)	66 (19%)	261 (73%)	**356**
Pre Chemical Engineering	9 (16%)	12 (21%)	37 (64%)	**58**
Pre Chemistry	2 (8%)	5 (21%)	17 (71%)	**24**
Pre Civil Engineering	4 (10%)	6 (15%)	31 (76%)	**41**
Pre Computer Engineering	7 (12%)	18 (31%)	33 (57%)	**58**
Pre Computer Science	18 (16%)	36 (32%)	57 (51%)	**111**
Pre Construction Management	1 (100%)	(0%)	(0%)	**1**
Pre Earth & Planetary Sciences	(0%)	2 (40%)	3 (60%)	**5**
Pre Electrical Engineering	5 (10%)	9 (19%)	34 (71%)	**48**
Pre Environmental Science	5 (22%)	3 (13%)	15 (65%)	**23**
Pre Mathematics	(0%)	2 (15%)	11 (85%)	**13**
Pre Mechanical Engineering	20 (14%)	37 (25%)	91 (61%)	**148**
Pre Nuclear Engineering	4 (25%)	6 (38%)	6 (38%)	**16**
Pre Physics	(0%)	3 (23%)	10 (77%)	**13**
Pre Physics & Astrophysics	(0%)	(0%)	1 (100%)	**1**
Pre Statistics	(0%)	(0%)	1 (100%)	**1**

4th Semester (Spring 2018)

- Of those initially interested in STEM:
  - (Pre) Biology has 32% of all STEM Majors, followed by (Pre) Biochemistry with 13% and (Pre) Mechanical Engineering with 12%.
  - Only 9% of students who in their 1st semester fell into the Low GPA group persisted within STEM, compared to 39% of the MM population, and 60% of the High GPA group.
  - 30% of these students switched into a non-STEM field.
- Of those initially in a non-STEM field:
  - 7% of these students switched into a STEM field, most of whom initially fell into the High GPA group.
- Of those who switched into a STEM field, 38% were (Pre) Biology, and 7% were Pre Mechanical Engineering, 7%. (Pre) Computer Science, and 7% (Pre) Biochemistry.

FINDING 5: PELL RECEIVED AND 1ST GENERATION AND THE MURKY MIDDLE

PELL RECEIVED:
Within 1st semester GPA groups, Pell received students are about equal in their performance distribution, regardless of their STEM or non-STEM status, with 23% in the MM , and the majority in the High GPA group.

When compared to non-Pell received students. Non-Pell students had a smaller percentage of students in the Low GPA and MM GPA groups, and over 70% in the High GPA group.

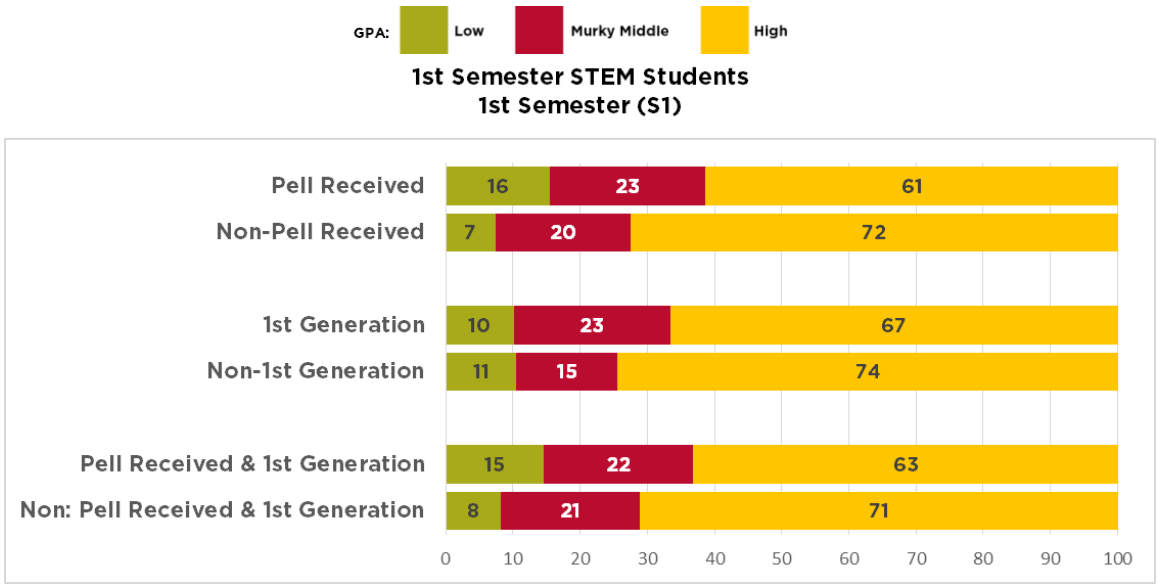
1ST GENERATION:
First generation non-STEM students perform slightly higher than STEM. However, the reverse is seen for non-1st Generation students.

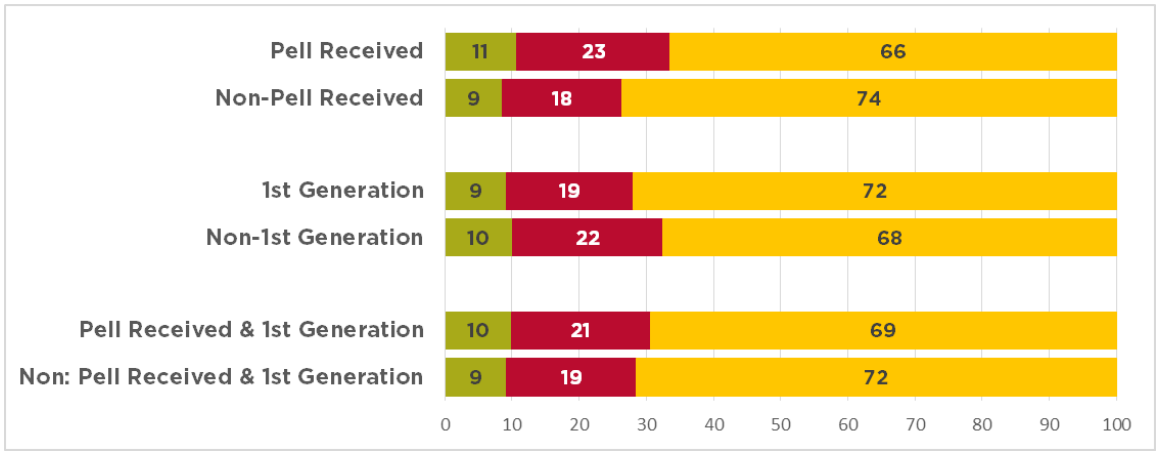
PELL RECEIVED & 1ST GENERATION:
Within STEM students, the MM percentages are equal. The difference is that fewer non-Pell & non-1st Generation students are in the Low GPA group.

For non-STEM students, there is not difference between Pell & 1st Generation and non-Pell & non-1st Generation students. And, the values are about comparable to the non-Pell & non-1st Generation STEM student.

	GPA 1st Semester - STEM Majors				**GPA 1st Semester - non-STEM Majors**			
	Low (<=1.99)	**MM (2.0 - 2.99)**	**High (>=3.0)**	**All**	**Low (<=1.99)**	**MM (2.0 - 2.99)**	**High (>=3.0)**	**All**
N	111	229	738	**1078**	215	454	1618	**2287**
Pell Received	59	88	233	380	98	209	607	914
% Pell Received	53.15%	38.43%	31.57%	35.25 %	45.58%	46.04%	37.52 %	39.97 %
non-Pell Received	52	141	505	698	117	245	1011	1373
% non-Pell Received	46.85%	61.57%	68.43%	64.75 %	54.42%	53.96%	62.48 %	60.03 %
1st Generation	83	189	541	813	152	314	1196	1662
% 1st Generation	74.77%	82.53%	73.31%	75.42 %	70.70%	69.16%	73.92 %	72.67 %
non-1st Generation	28	40	197	265	63	140	422	625
% non-1st Generation	25.23%	17.47%	26.69%	24.58 %	29.30%	30.84%	26.08 %	27.33 %
Pell + 1st Gen	51	77	219	347	80	167	559	806
% Pell + 1st Gen	45.95%	33.62%	29.67%	32.19 %	37.21%	36.78%	34.55 %	35.24 %
Non: Pell+1st Gen	60	152	519	731	135	287	1059	1481
% Non: Pell+1st Gen	54.05%	66.38%	70.33%	67.81 %	62.79%	63.22%	35.44 %	35.24 %

Percent values (%) reflect relationship among attributes, within a GPA category; the relationship within GPA categories across all attributes. For example, of the Murky Middle students, 38.43% are Pell Receiving, while 61.57% are not.


GPA:
Low
Murky Middle
High
1st Semester STEM Students
1st Semester (S1)
Pell Received
16
23
61
Non-Pell Received
7
20
72
1st Generation
10
23
67
Non-1st Generation
11
15
74
Pell Received & 1st Generation
15
22
63
Non: Pell Received & 1st Generation
8
21
71
0
10
20
30
40
50
60
70
80
90
100


1st Semester Non-STEM Students
1st Semester (S1)
Pell Received
11
23
66
Non-Pell Received
9
18
74
1st Generation
9
19
72
Non-1st Generation
10
22
68
Pell Received & 1st Generation
10
21
69
Non: Pell Received & 1st Generation
9
19
72
0
10
20
30
40
50
60
70
80
90
100

FINDING 6: GENDER, ETHNICITY, AND THE MURKY MIDDLE

For the following graphs, you will see consecutive semesters. The later semesters are based on the group assigned during the 1st semester, so we are not able to see if, for example, the 306 high performing females in STEM for the 4th semester are still in a STEM major, or if they changed their GPA group, just that they are still enrolled at the university.

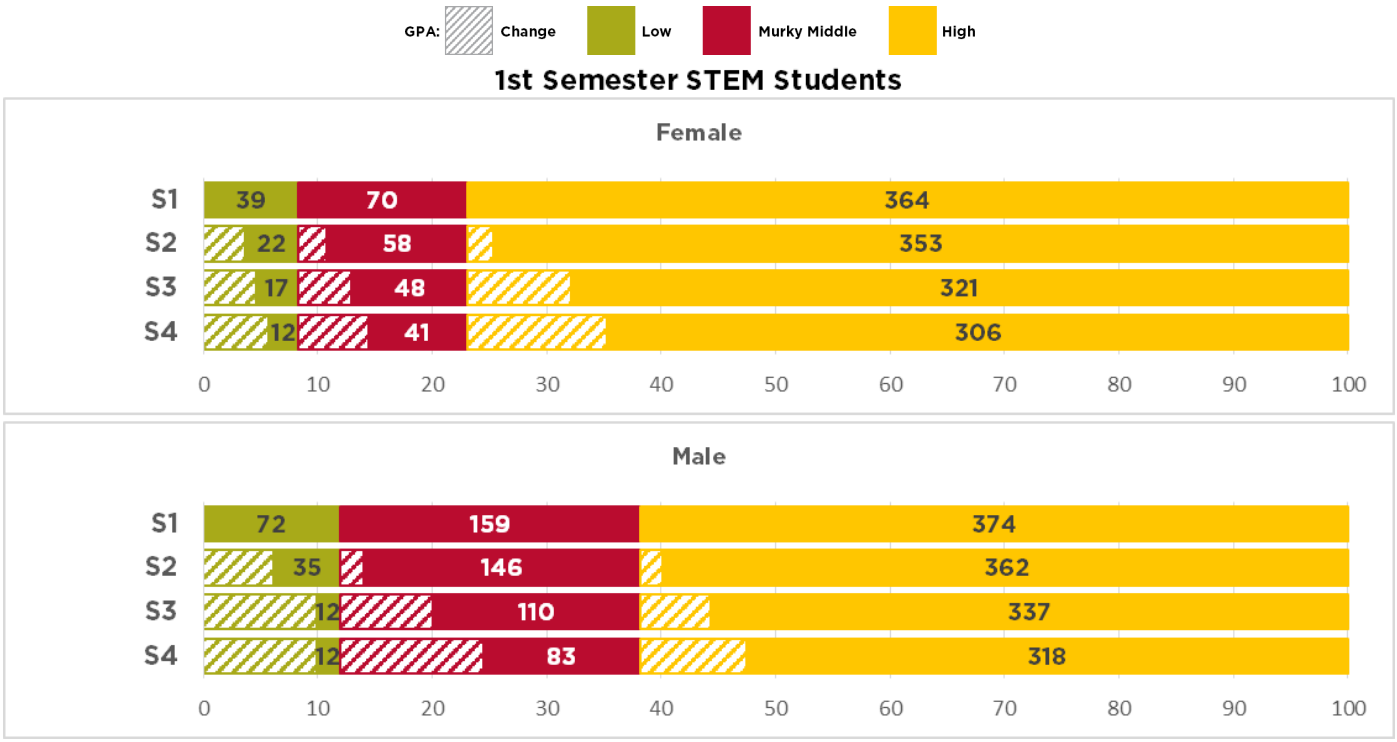
The values listed on each bar are the number of students, where the percentage is the size of the bar.

Gender

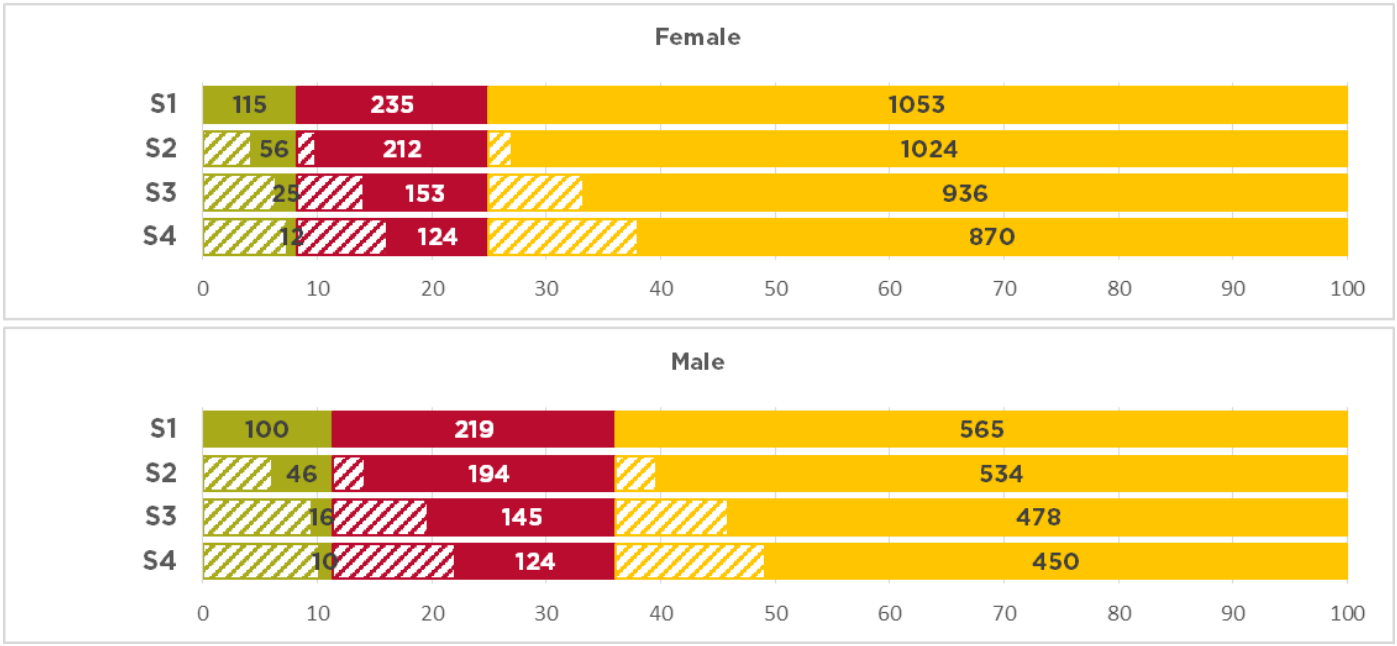
FEMALES: Slightly less than 10% of both STEM and non-STEM females were in the Low GPA group after their 1st semester, and by the 4th semester, only a small portion of these students were still enrolled at UNM. And, performance distribution between STEM and non-STEM are about the same.

MALES: Slightly more than 10% of both STEM and non-STEM students were in the Low GPA group and performance distribution between STEM and non-STEM are about the same.

FEMALES VS. MALES: There is a higher percentage of females in the High GPA group after the 1st semester compared to males. And when we look at retention of these students to the 4th semester, again, not necessarily within a STEM major, but at the university, there are slightly more males from the MM, and females from the High GPA groups retained, but overall, percent retention is about equal between genders, with female retention at 10%, 53%, and 83% for the Low, Middle, and High GPA groups respectively, compared to 10%, 57%, and 80% for males.



1st Semester Non-STEM Students

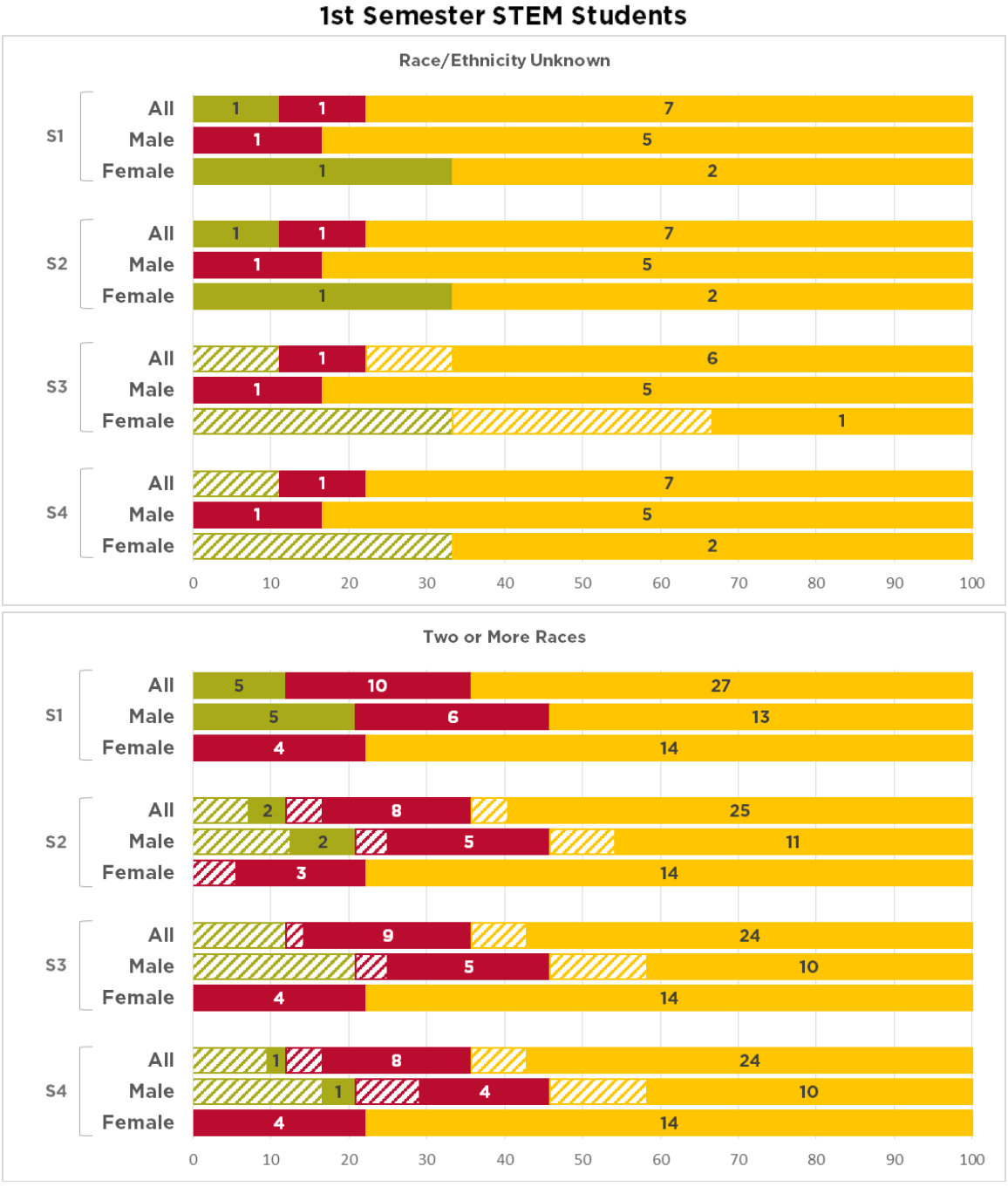


Gender & Ethnicity

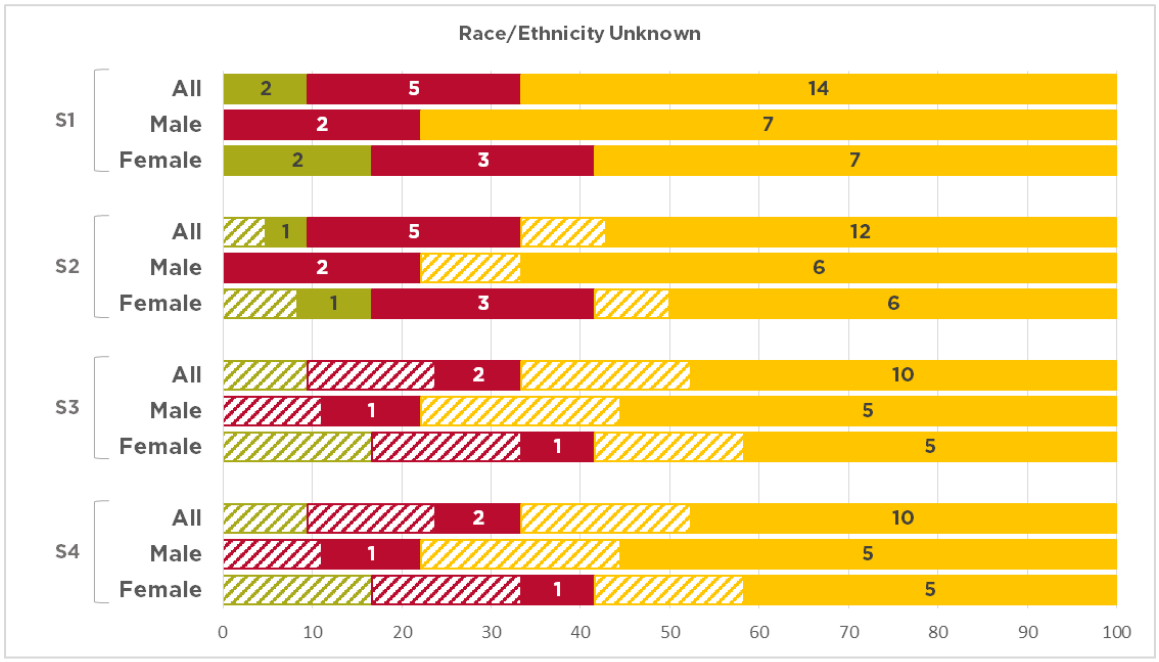
GPA: Change Low Murky Middle High

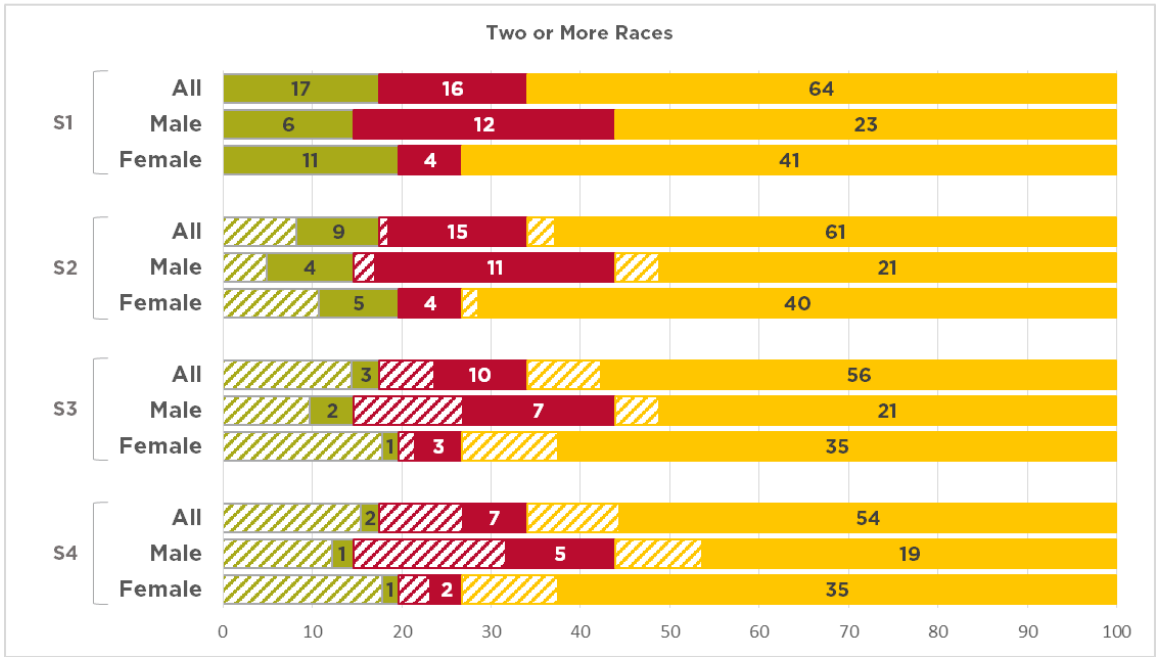
The following data are represented with Semester 1 on top, with 3 groups shown – All students, and then male vs. females. And then each semester after, as with the Gender only graphs.

RACE/ETHNICITY UNKNOWN AND TWO OR MORE RACES: These two groups have very low sample sizes, making it difficult to draw any solid conclusions.

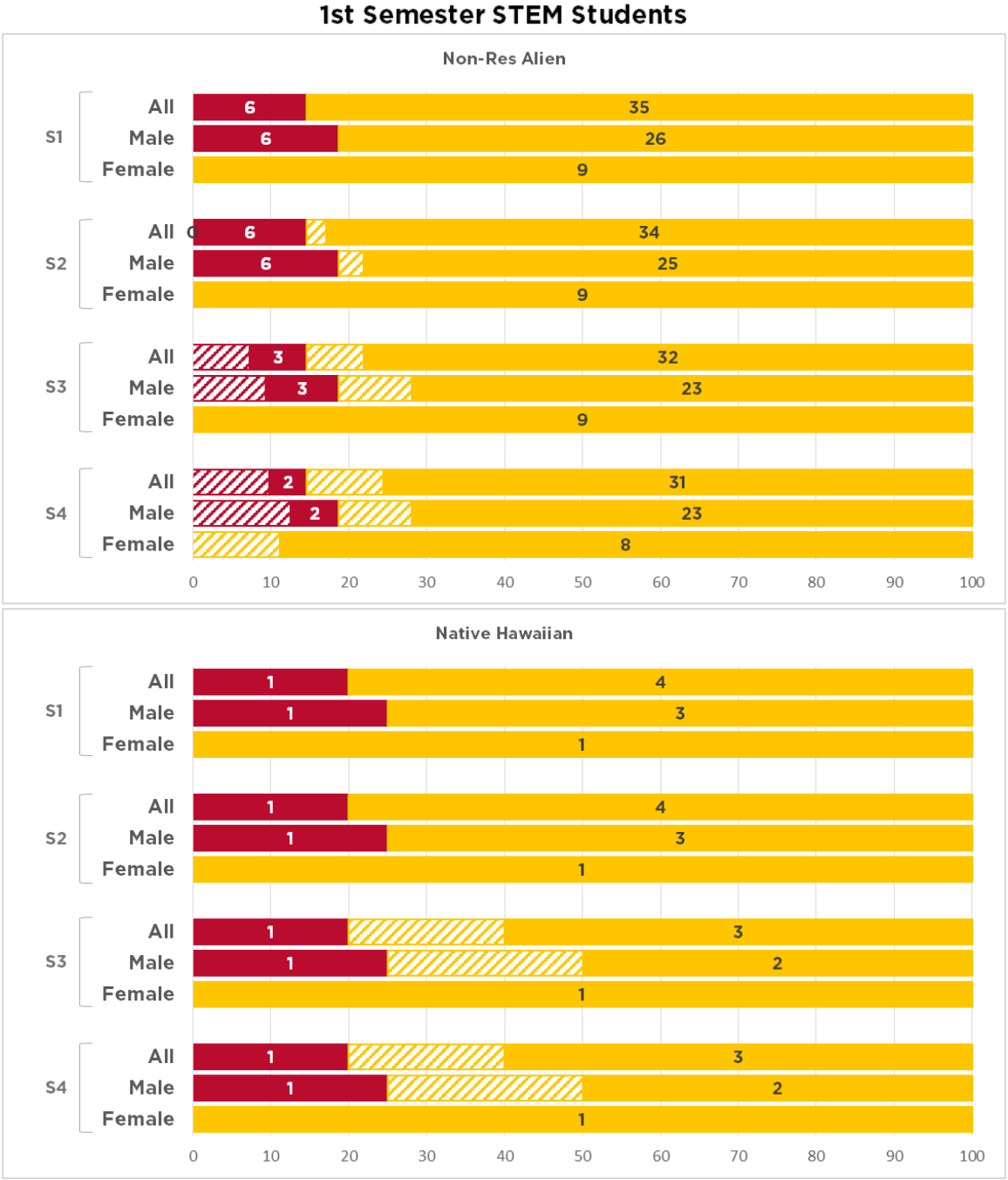


1st Semester Non-STEM Students

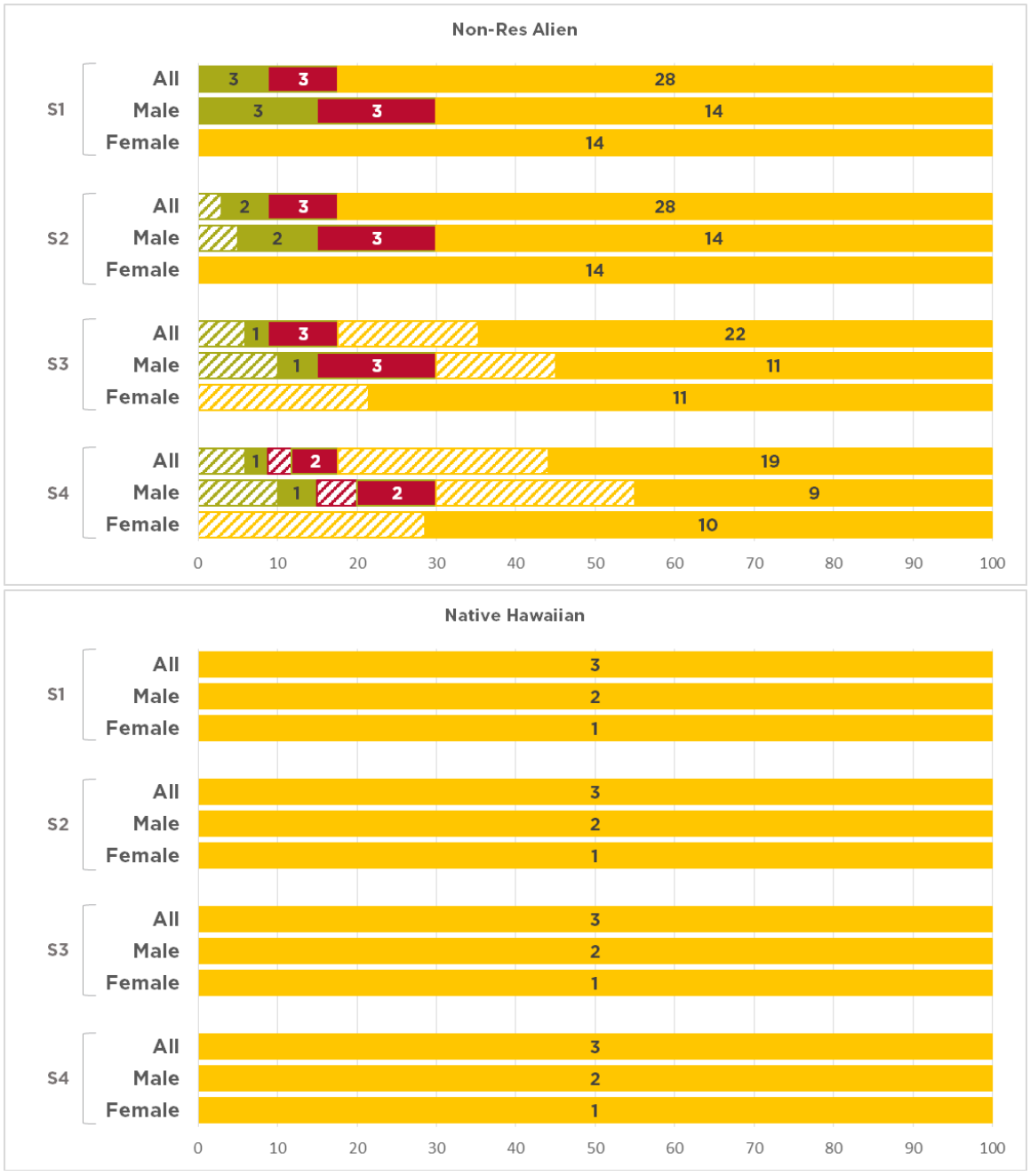




NON-RESIDENT ALIENS AND NATIVE HAWAIIANS: Students fall predominantly 1st Semester High GPA students. But, that could in part be due to the small sample sizes (35 STEM & 28 non-STEM non-Resident Aliens and 4 & 3 for Native Hawaiians).

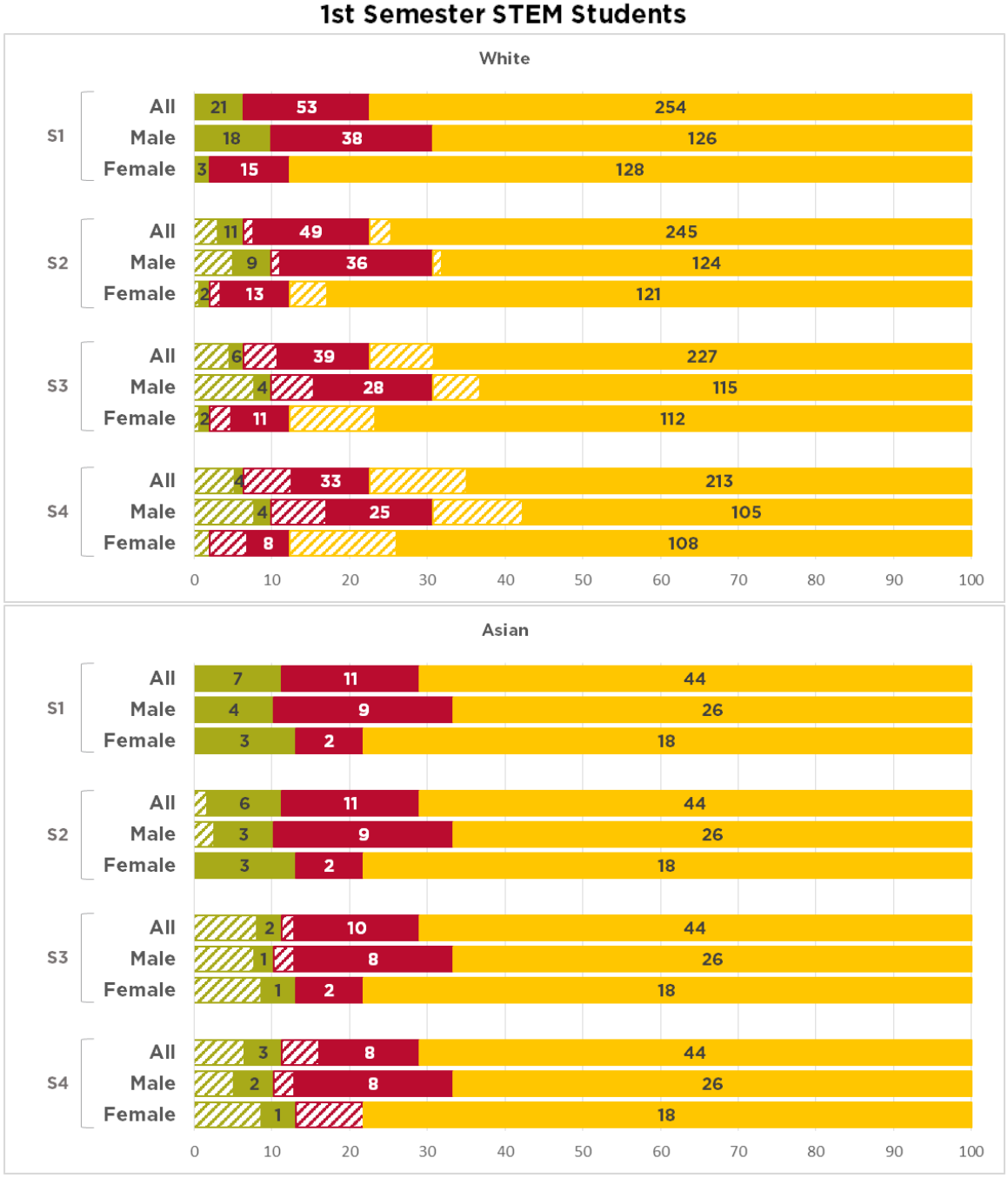


1st Semester Non-STEM Students

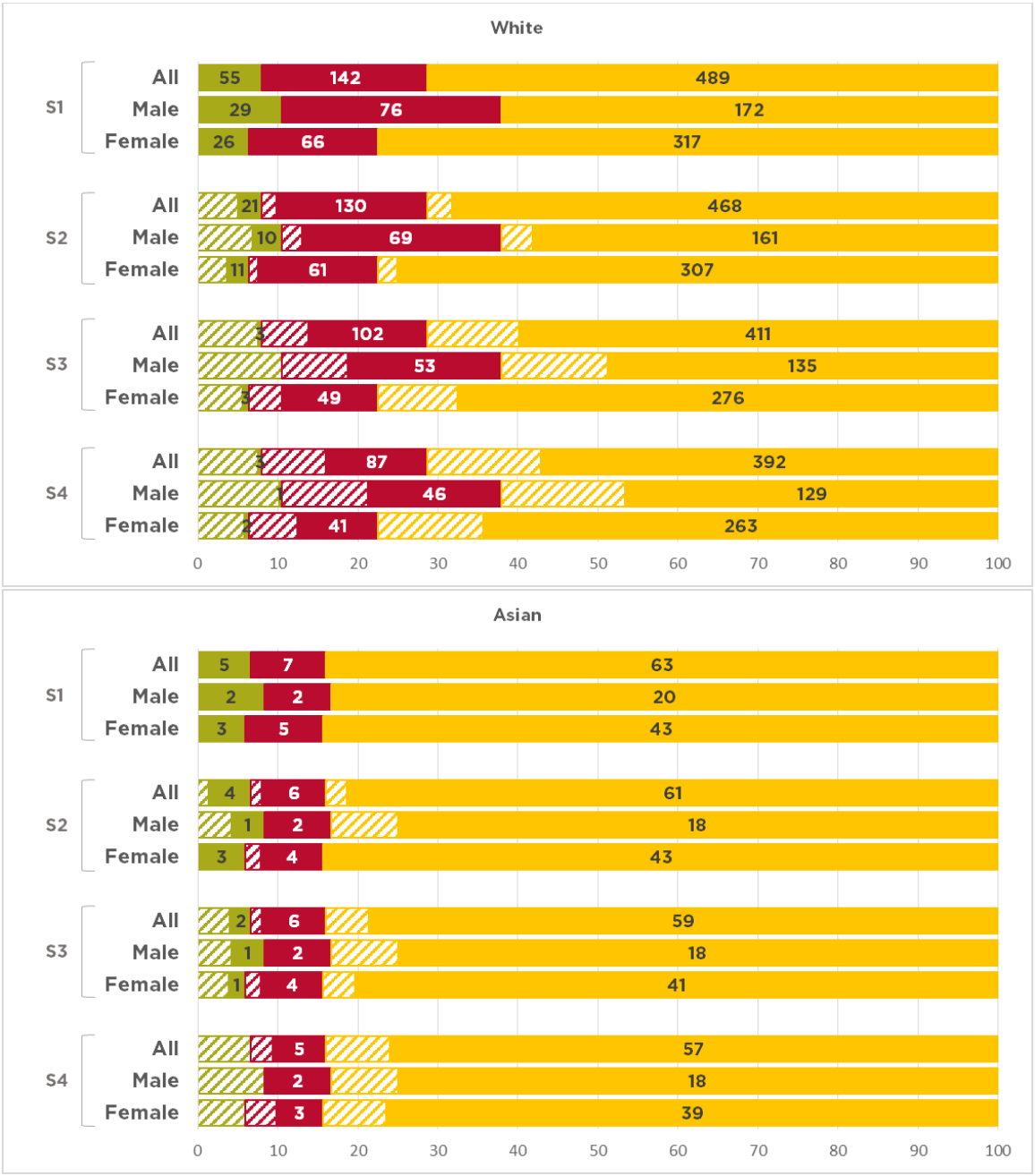


WHITE AND ASIAN: At least 70% of STEM students are in the High GPA group after their 1st semester, with non-STEM Asians outperforming STEM Asians and White STEM students outperforming White non-STEM students.

Close to the non-STEM White students are non-STEM Hispanic students, but STEM Hispanics students seem to struggle more with STEM.

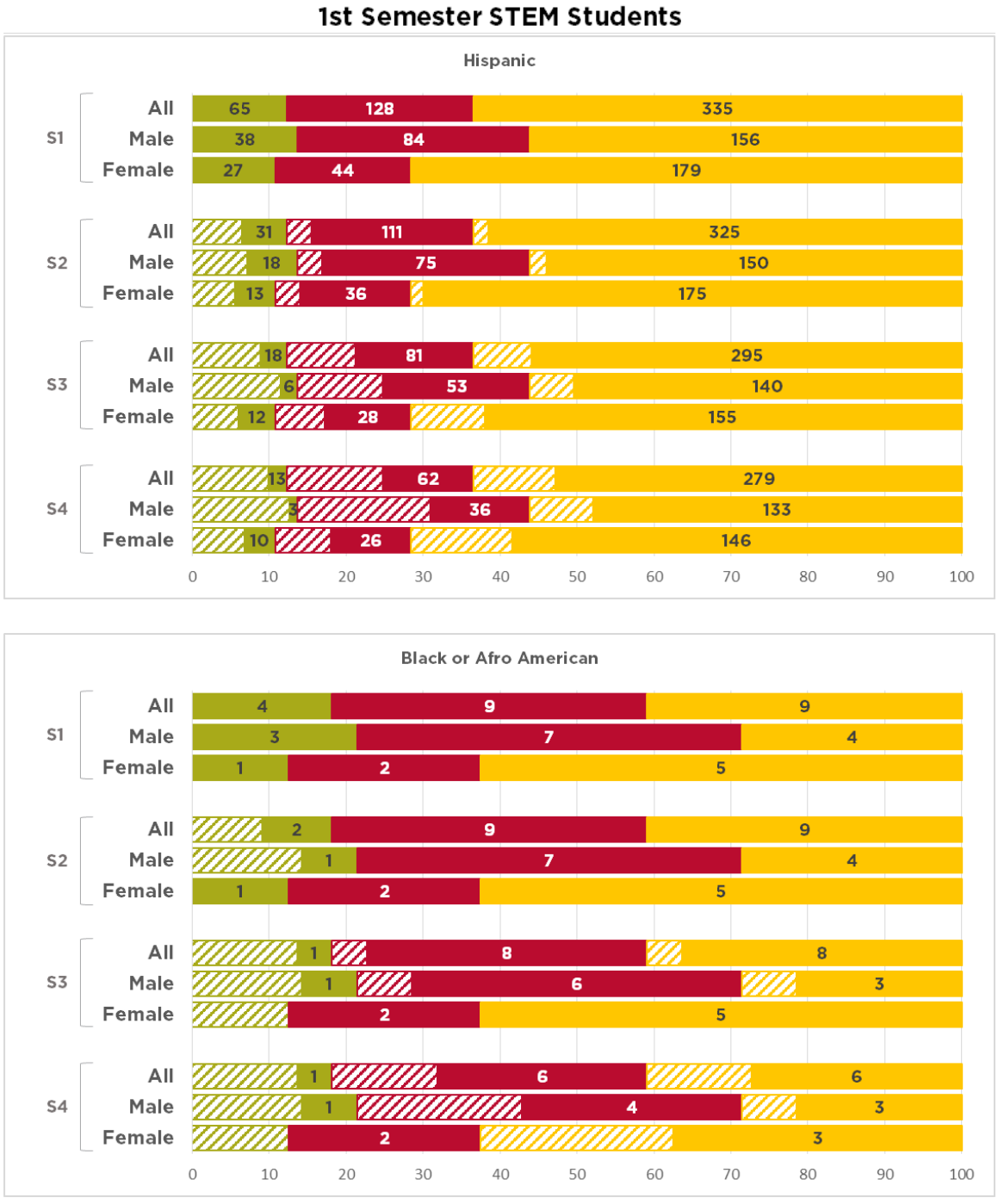


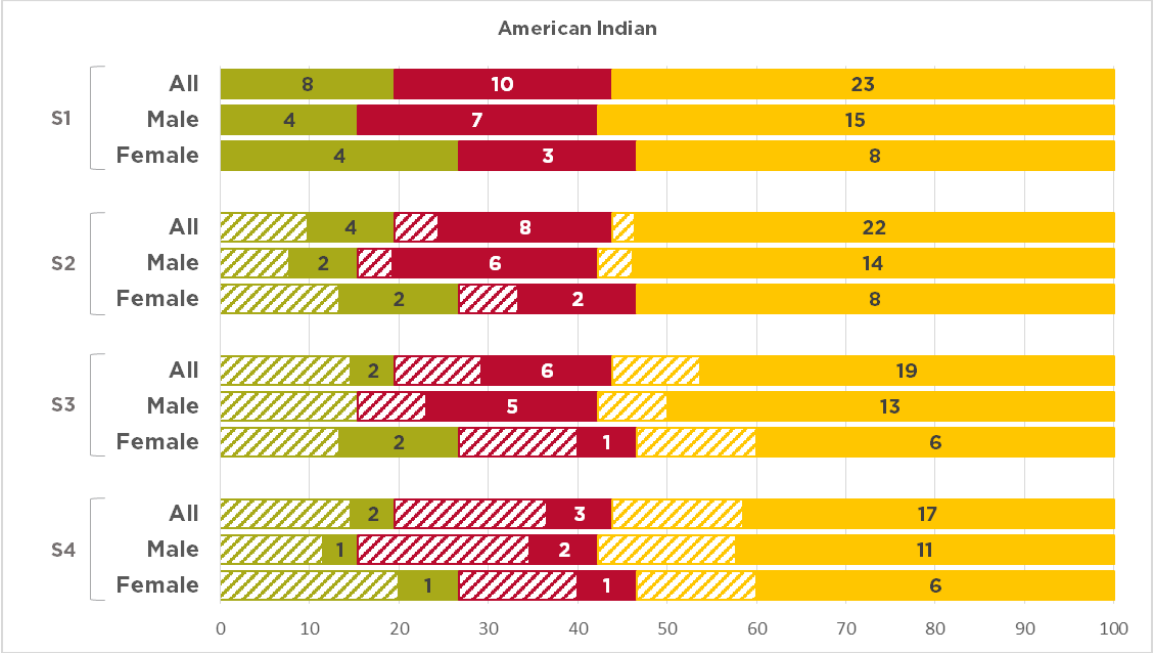
1st Semester Non-STEM Students



HISPANIC, BLACK OR AFRO AMERICAN, AND AMERICAN INDIANS: Most have more than 30% of students within either the MM or Low GPA groups, in other words, less than 70% of students are in the High GPA group. This is in contrast to all other ethnic groups, with more than 70% of students falling within the High GPA group after the 1st semester.

First semester Hispanic and Black or Afro American females have a larger proportion of students in the High GPA group than males of the same ethnicity, but the opposite is seen for American Indian students.




American Indian
S1
All
Male
Female
S2
All
Male
Female
S3
All
Male
Female
S4
All
Male
Female
8
10
23
4
7
15
4
3
8
4
8
22
2
6
14
2
2
8
2
6
19
2
5
13
2
1
6
2
3
17
1
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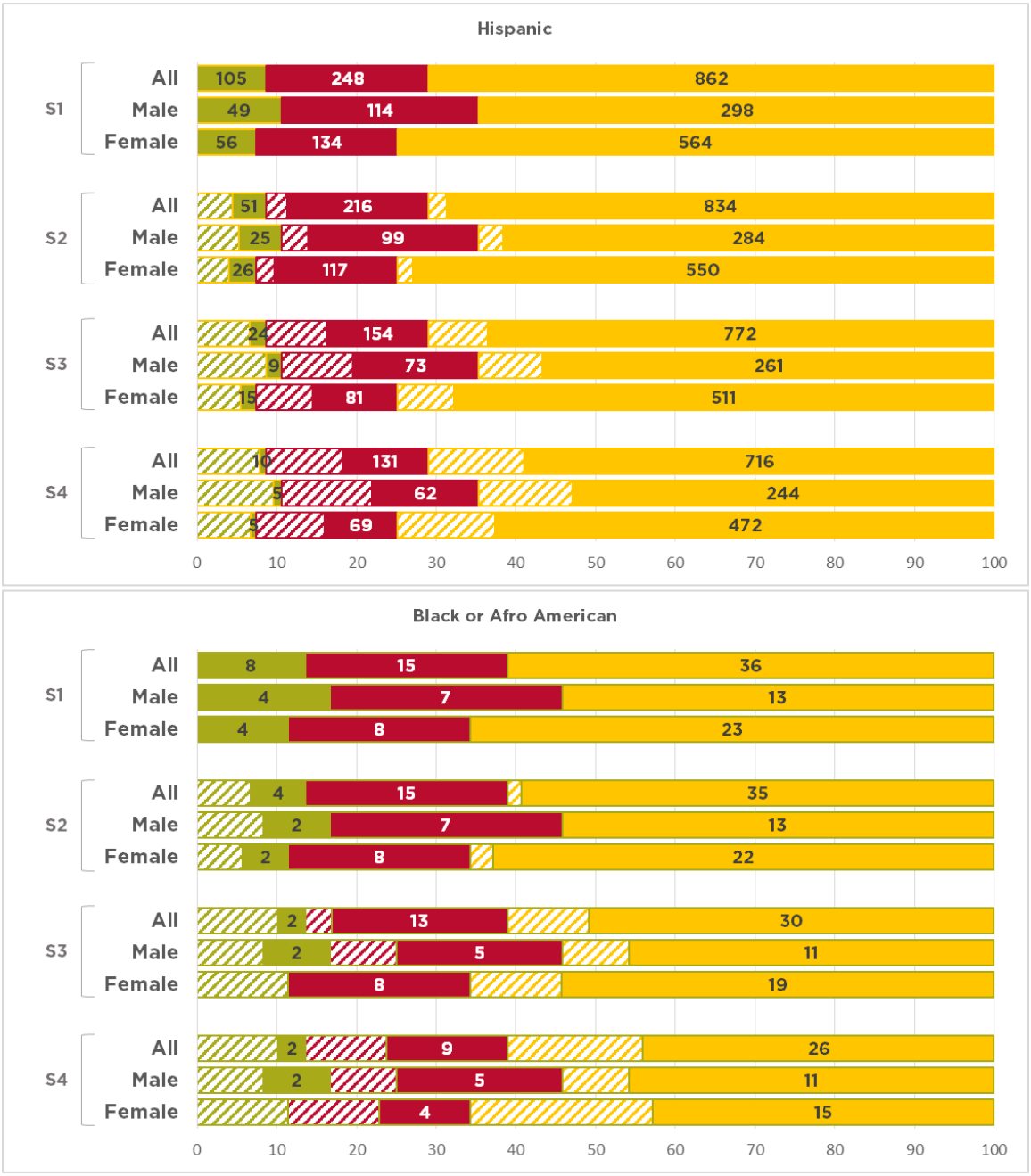
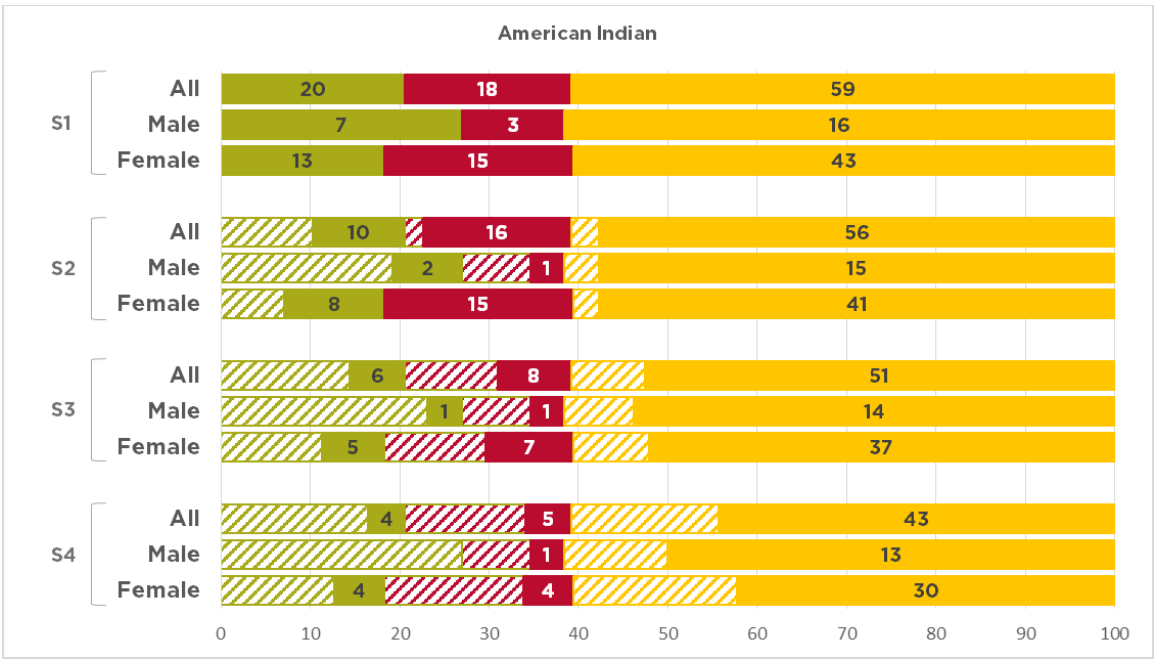
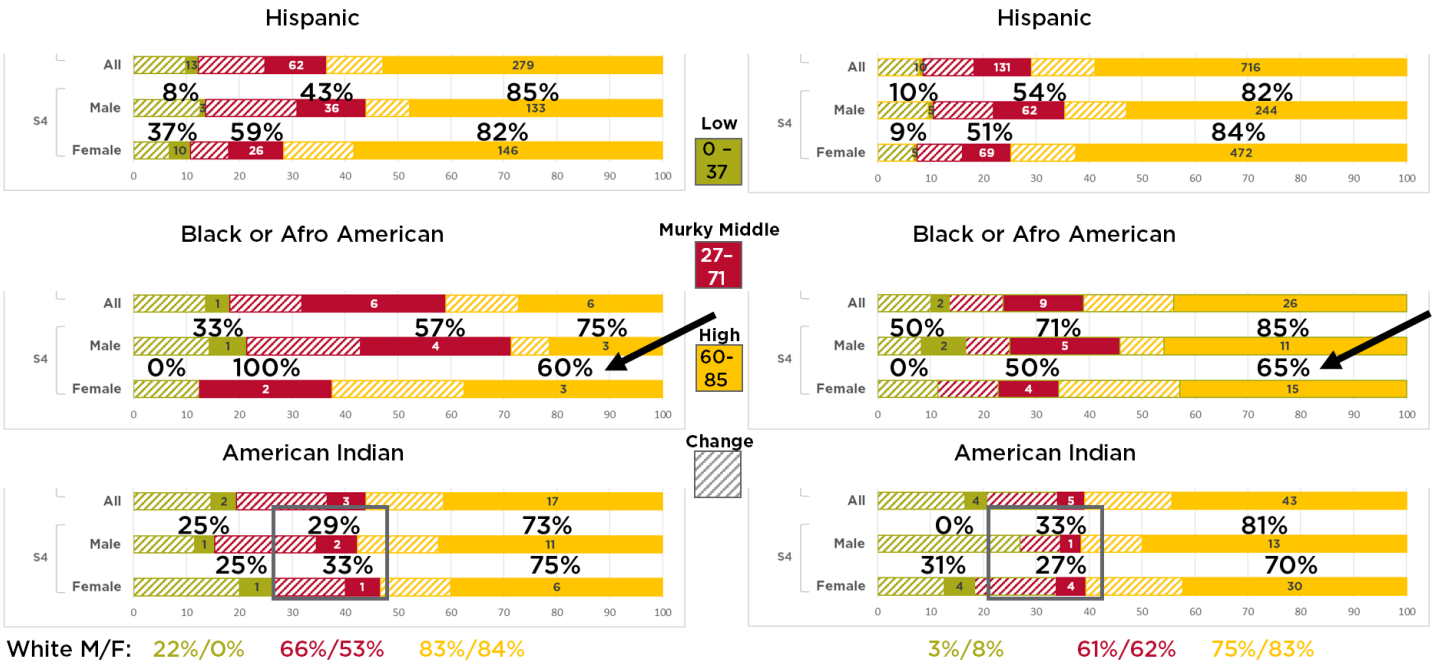
11
1
1
6
0
10
20
30
40
50
60
70
80
90
100

1st Semester Non-STEM Students





By the 4th semester, removing the few outliers, retention rates within the Low GPA groups range from 0 to 37, MM from 27 to 71, and 60 – 85 for 1st Semester High GPA students. With noticeable low retention for High GPA Black females and MM American Indian students.



FINDING 6: STEM MURKY MIDDLE COHORT – SEMESTER 4

The following are for Semester 4 for the students that fell into the 1st Semester STEM MM. The gray are students who are no longer in STEM, or have left the university. Of those that remained in STEM, their current GPA is reflected in these graphs.

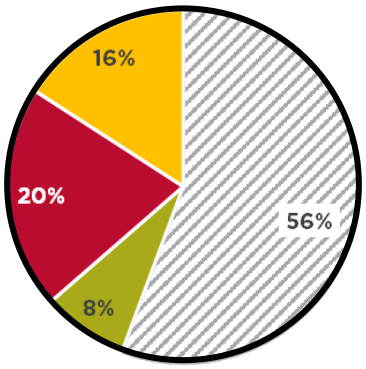
GPA: Change Low Murky Middle High

**Note: Gray = 1st Semester MM student STEM (or non-STEM) retention: those who are no longer in STEM (or non-STEM) OR have left the University.*

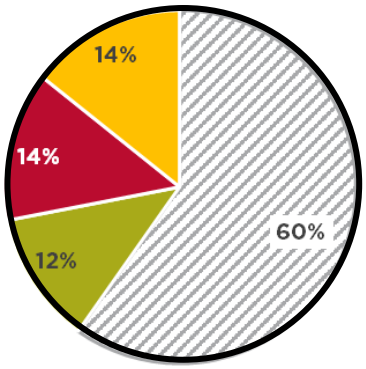
PELL RECEIVED AND 1ST GENERATION: By the 4th semester, more non-STEM 1st semester MM students are retained than 1st Semester MM STEM students.

4th Semester GPA Standing for 1st Semester Murky Middle STEM Students

Pell Received

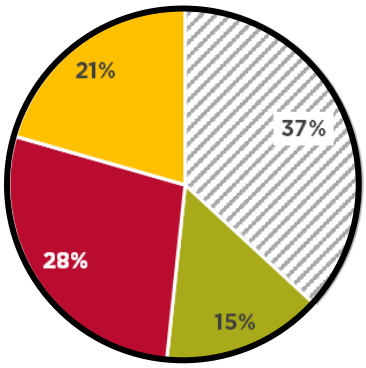


1st Generation

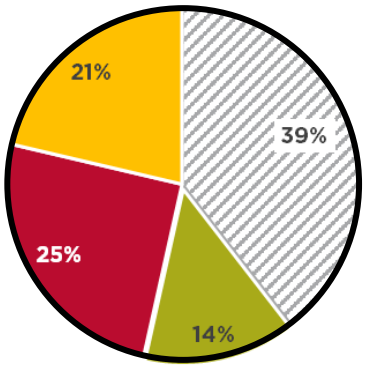


4th Semester GPA Standing for 1st Semester Murky Middle non-STEM Students

Pell Received

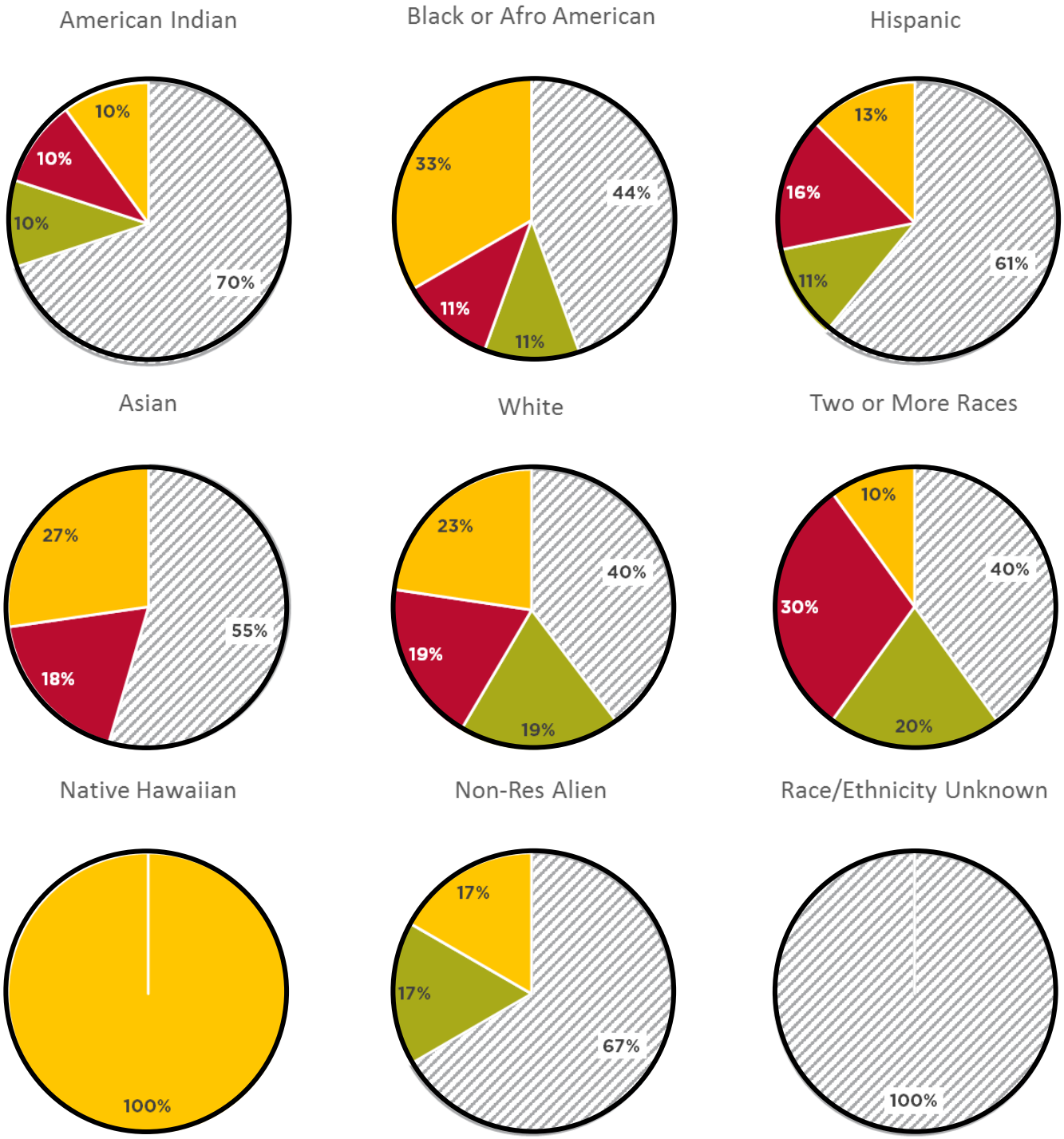


1st Generation



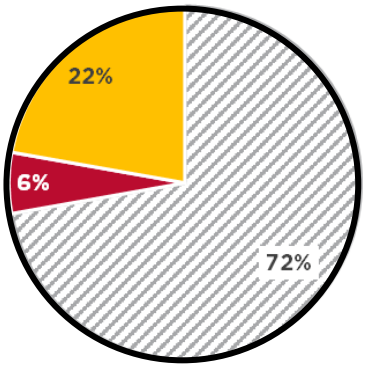
ETHNICITY: Once outliers are removed due to low sample size (Native Hawaiian; non-Resident Alien; Two or More Races, and Ethnicity Unknown) American Indian experienced the lowest retention within STEM. Black or Afro American has the greatest shift into higher GPAs. Whites and 2 or More Races have about equal retention, while all other ethnicities see a lower retention within STEM for the 1st semester MM students.

4th Semester GPA Standing for 1st Semester Murky Middle STEM Students

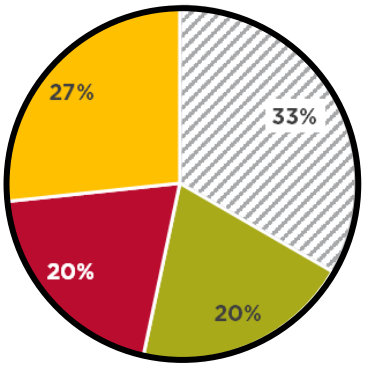


4th Semester GPA Standing for 1st Semester Murky Middle non-STEM Students

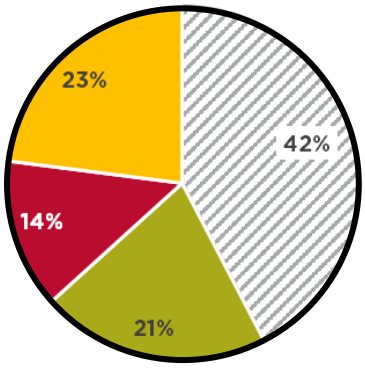
American Indian



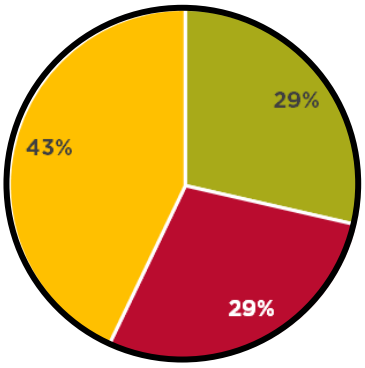
Black or Afro American



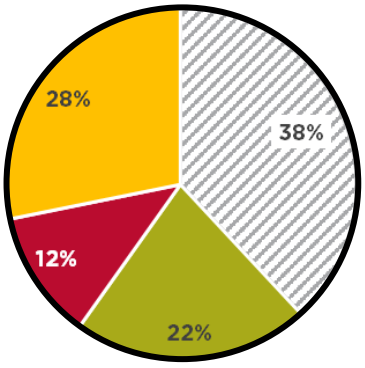
Hispanic



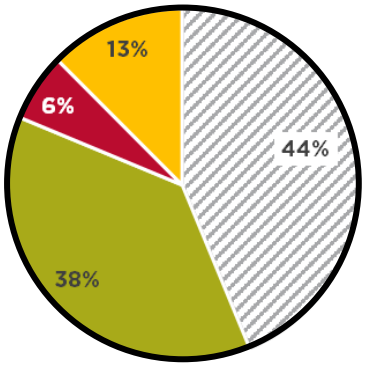
Asian



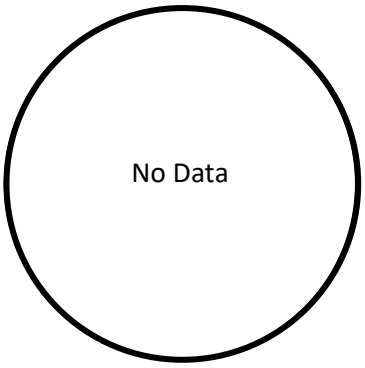
White



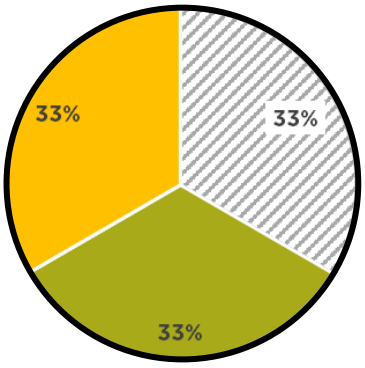
Two or More Races



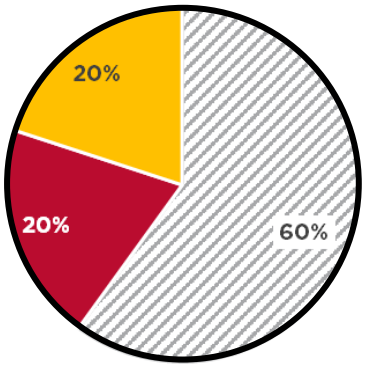
Native Hawaiian



Non-Res Alien

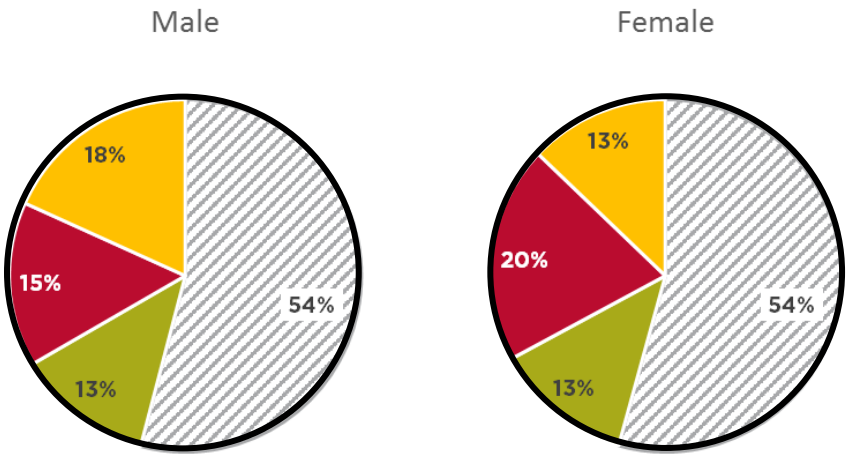


Race/Ethnicity Unknown

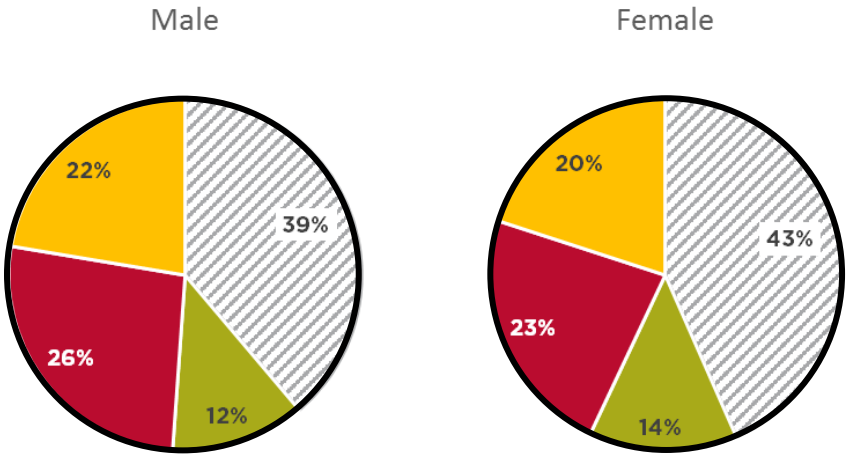


GENDER: There is not much difference between gender within STEM and non-STEM. However, retention to the 4th semester for the 1st semester MM is higher for non-STEM students.

4th Semester GPA Standing for 1st Semester Murky Middle STEM Students



4th Semester GPA Standing for 1st Semester Murky Middle non-STEM Students

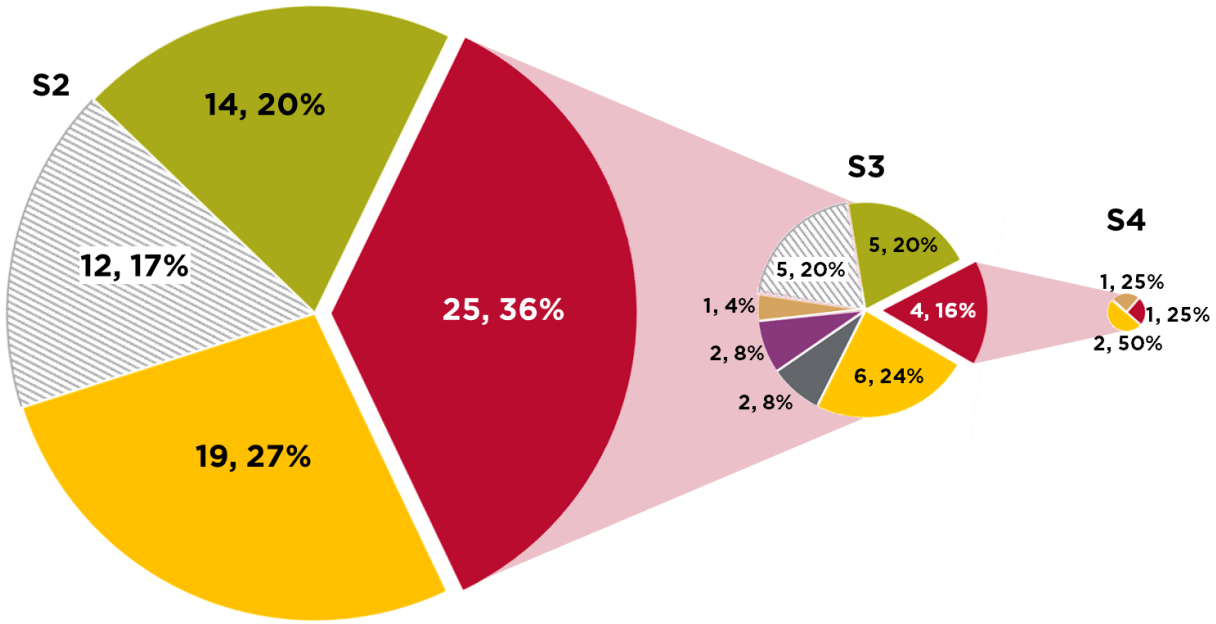


FINDING 7: TRACKING THE MURKY MIDDLE

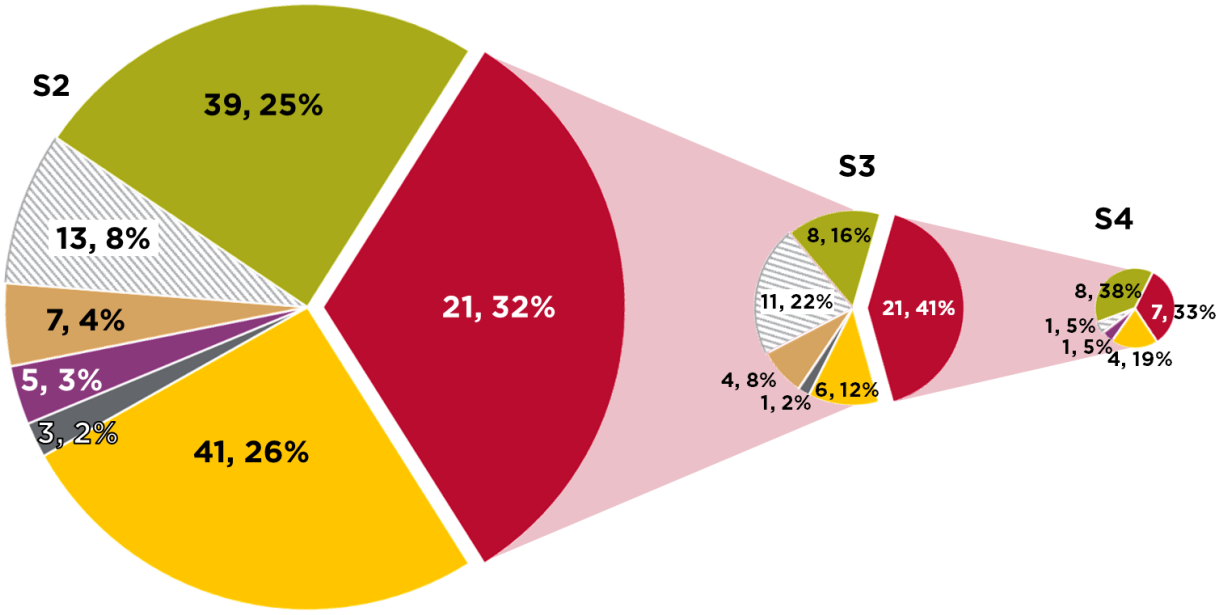
Starting populations were 1st semester STEM MM males and females. These students were then observed for the following semester status. From that semester, those who remained in the MM were followed into the next semester, through Semester 4.

By the 4th semester, only 1 of the initial 25 MM females and 7 of 21 males remained in the STEM MM. What happened to the other 24 and 14 students, respectively? You can see as we look semester by semester, some are moving up and out of the MM GPA group, some switched out of STEM, and others fell into the Low GPA group. But, it is clear that the majority of these initial MM students are not remaining and excelling within STEM.

FEMALES: Starting Population = 70 STEM 1st Semester Murky Middle STEM



MALES: Starting Population = 159 STEM 1st Semester Murky Middle STEM



APPENDIX I – STEM MAJORS USED FOR THIS STUDY

Astrophysics
Biochemistry
Biology
Chemical Engineering
Chemistry
Civil Engineering
Computer Engineering
Computer Science
Construction Engineering
Construction Management
Earth & Planetary Sciences
Electrical Engineering
Environmental Science
General Engineering
Mathematics
Mechanical Engineering
Nuclear Engineering
Physics
Statistics