

# Predictors of Student Success in Calculus and Precalculus at SDSU

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The SDSU Mathematics and Statistics Department made significant changes in its Precalculus and Calculus classes starting in Fall 2015. At the same time, a determined effort was made to get good data on student performance and to understand the impediments to success. One key reform was the introduction of the ALEKS PPL<sup>1</sup> system to gauge student readiness for calculus. This change was motivated by a Mathematical Association of America report<sup>2</sup> attributing lack of precalculus skills as a significant contributor to failure in calculus.

This report presents the main results of our study of the placement system and of related issues concerning student success. It also explains some of the changes that have been made because of our analysis. Here are two key findings.

1. ALEKS PPL scores are highly correlated with success in calculus. Each increase of one point in the ALEKS PPL score increases the likelihood of receiving an A in Math 150 Calculus 1 (for scientists and engineers) by 2 percentage points, and the likelihood of getting a B increases dramatically (from 35% to 65%) near the cutoff used for placement into Calculus 1.
2. Precalculus grades are also well correlated with success in calculus, but a high grade is required. A student with a grade of C in Math 141 Precalculus is unlikely to receive a passing grade in Calculus 1, while a student with a B+ or better in Precalculus is likely to receive a B- or better in Calculus 1.

This report covers four semesters at SDSU, Fall 2016, Spring 2017, Fall 2017 and Spring 2018. Section 1 is an executive summary of the main results. Section 2 gives more detail about the context for using ALEKS for placement at SDSU and Section 3 gives some concluding remarks and plans for the future. Appendix A and Appendix B take a deeper look at student performance in M150 and M141, respectively. We break down the student population with regard to 3 parameters: Residence Status, Entrance Method (how the prerequisite was satisfied, e.g. ALEKS placement), and Student Level. We give tables listing the number of students according to these parameters as well as statistical information about student performance in the course for several subpopulations. Charts show student performance in Math 150 as a function of the ALEKS placement score, and as a function of Math 141 grade.

Appendix C focuses on student use of ALEKS. It gives basic data about the number of students taking the assessment and the scores received. We also show statistics on score improvement for students that took multiple proctored assessments, and statistics for the difference between proctored and unproctored scores.

## 1 Executive Summary of Findings and Steps Taken

1. Figure 1 shows the proportion of A’s B’s and C’s as a function of ALEKS score for the Fall 2017 and the Spring 2018 M150 students. More detail on data for this chart is given in Appendix A, but it is evident that, as the ALEKS score increases, the proportion of As received increases steadily, roughly 2 percentage points for each increase of 1 point in ALEKS. The proportion of Bs also increases significantly. It is particularly interesting to see the steep increase near an ALEKS score of 76—the cutoff for Calculus recommended by ALEKS—from roughly 35% Bs to 65% Bs. The pass rate also increases, but less noticeably.

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<sup>1</sup>ALEKS PPL stands for Assessment and LEarning in Knowledge Spaces for Placement, Preparation, and Learning. It is an adaptive learning program that uses data from millions of prior uses to predict areas of weakness and remediate each persons specific areas of need.

<sup>2</sup>*Insights and Recommendations from the MAA National Study of College Calculus*, D. Bressoud, V. Mesa, C. Rasmussen, Ed., MAA Press, 2015.

2. Figure 2 shows box plots for the ALEKS scores of students enrolled in M150 that had previously taken M141 for both Fall 2017 and Spring 2018. The horizontal axis labels show the number of students that took M141 and received a given grade. The box plot shows that the ALEKS score increases steadily as the grade in M141 increases. For students that earned a B or below, neither the median nor the average are above the cutoff of 76 that ALEKS proposes for Calculus 1.
3. Students that placed into M150 via AP score did exceptionally well in M150, almost 90% received B- or better in Fall 2016. Students that placed in via ALEKS also did well, 82% received B- or better. Students that enter via M141 have an average grade more than 1 grade point lower than those that entered via ALEKS.
4. Later charts show that students that receive a B+ or better in M141 did pretty well in M150, roughly 60% received at least a B- (except in Fall 2017 when it dropped due to more difficult exams). There is a steep increase as the M141 grade goes from B to B+ (or from B+ to A- in Fall 2017). Students with a C had a pass rate below 40% and a B- or better rate of just 10-20%.
5. These results and other studies we have done suggest that attention should be paid not just to the pass rate of a course, but also to the rate of real success (we use B- or better), particularly for courses that serve as foundational prerequisites for other courses.
6. Domestic non-California students and foreign student do noticeably worse, particularly in M141, (averages are 1/2 grade or more below that of the whole class).
7. For unknown reasons, the number of students that placed into M150 using ALEKS dropped significantly from Fall 2016 to Fall 2017. This is surprising given that the messaging to students should have improved. It is important that students see, and take advantage of, the opportunity to use ALEKS learning modules to progress improve their score, and eventually place into M150.
8. Students that took more than one ALEKS assessment tended to improve their score significantly, by an average of roughly 10 points. This is a significant amount because the recommended range for precalculus is 61-75, a spread of 15 points.
9. A large number of students who were admitted to Calculus 1 because of a passing grade in Precalculus received ALEKS scores well below the ALEKS cutoff for Calculus 1. In fact the first quartile score below 60 points, which is the cutoff for Precalculus.

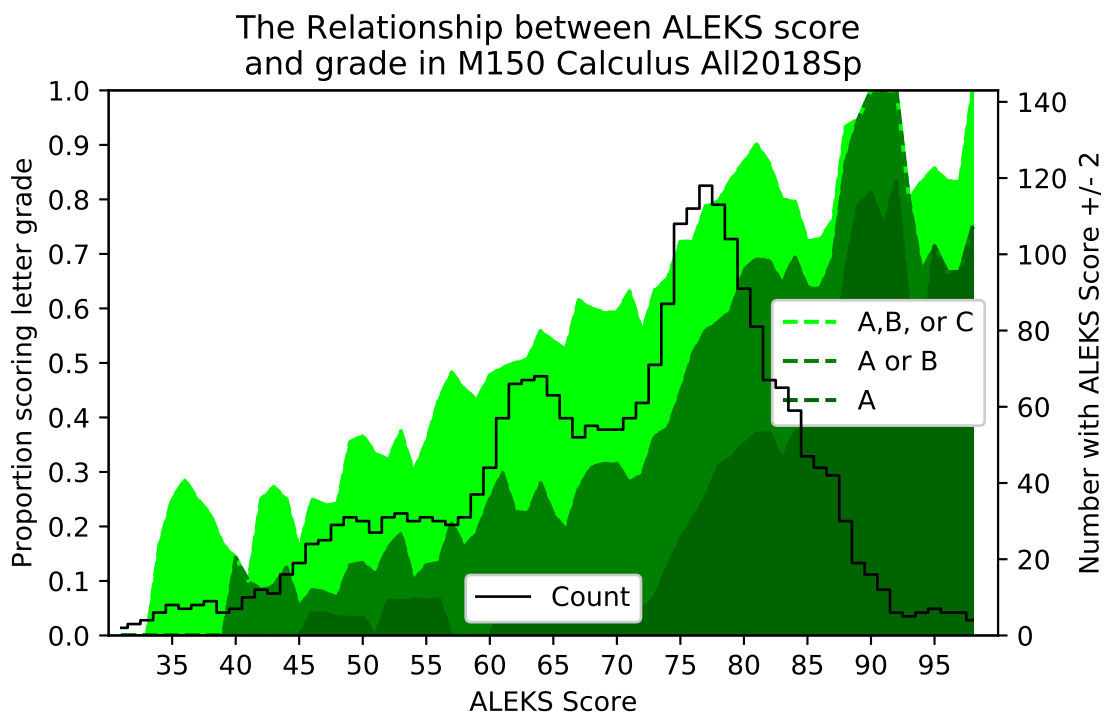
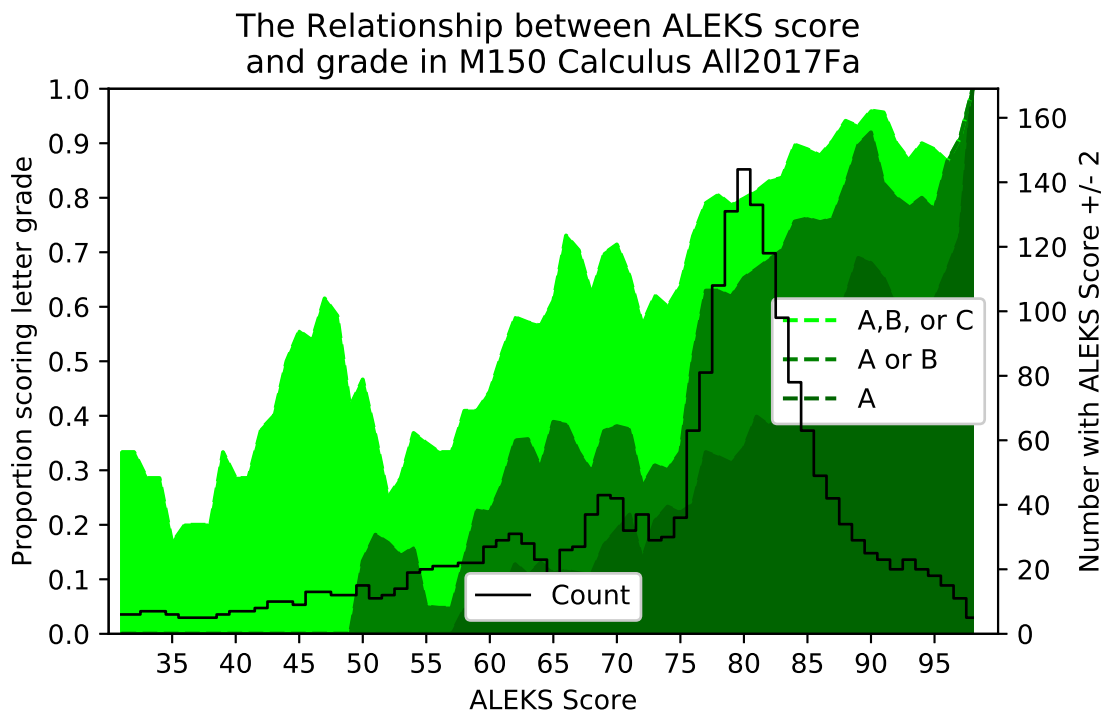


Figure 1: Math 150 Calculus 1 grades and ALEKS scores. For each ALEKS score the black line shows the number of students receiving that score  $\pm 2$ . The other graphs show the proportion of those students receiving an A- or better, a B- or better, and C or better.

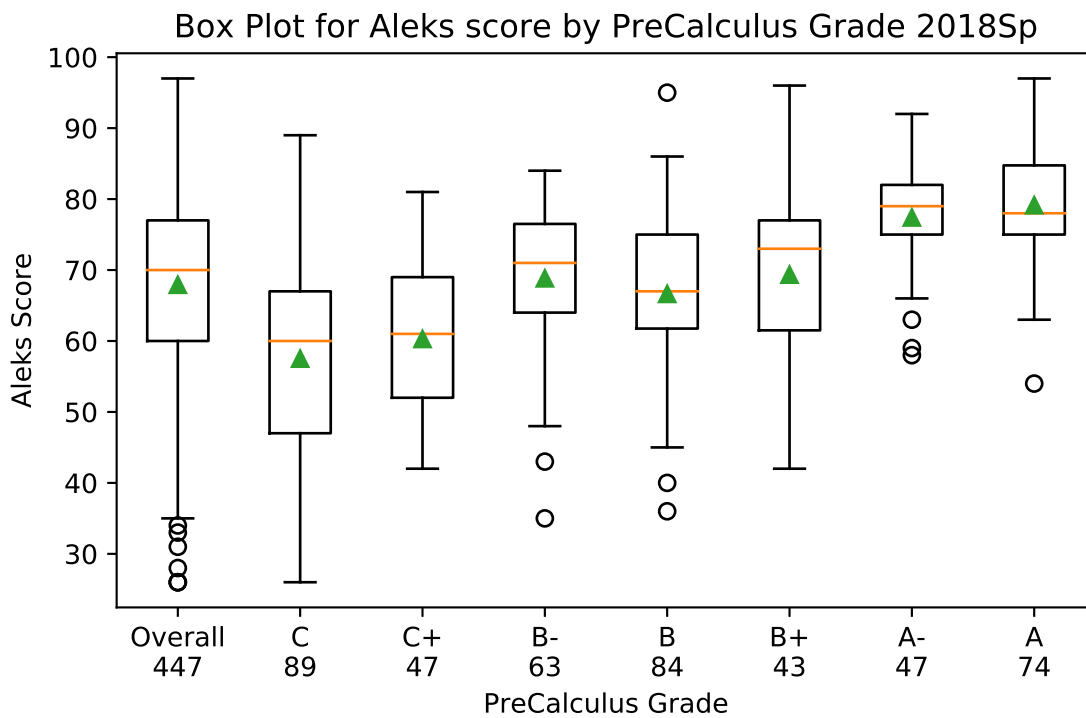
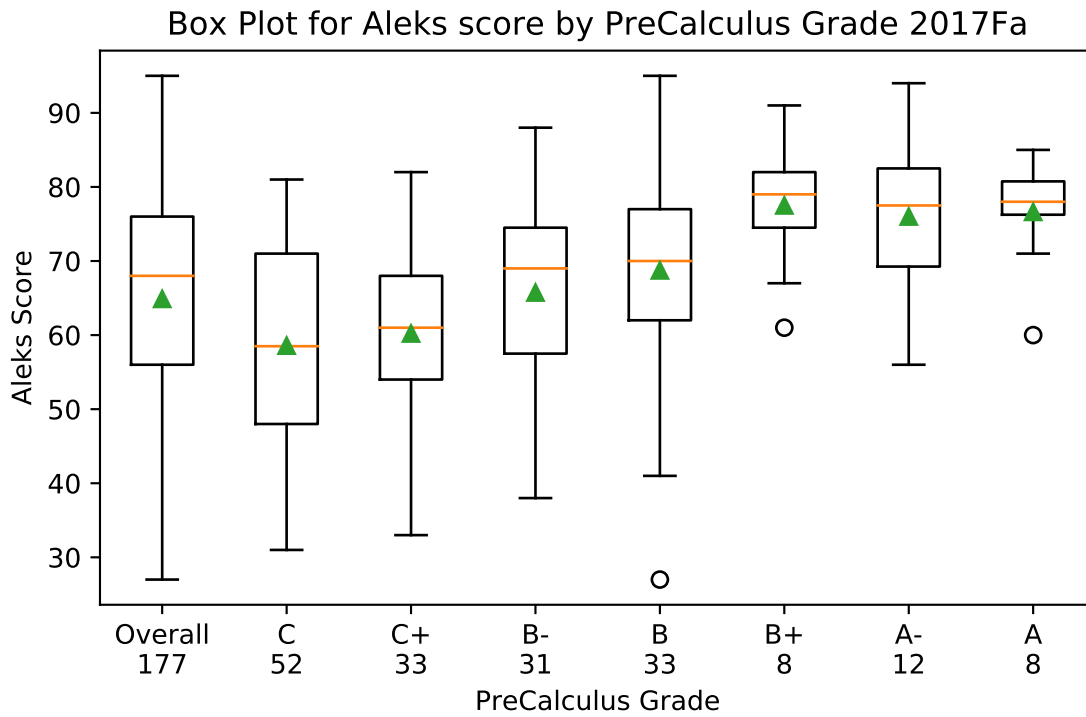


Figure 2: ALEKS score for students in Math 150 Calculus with a give Math 141 Precalculus grade

A number of changes have already been made due to the above observations.

1. In Fall 2017 and Spring 2018 we required a proctored ALEKS assessment of all students, for 5% of the student's grade. One objective was to ensure that students review fundamentals. A second objective was to get solid data about the performance of the whole class on ALEKS. This data enabled us to create the charts in Figures 1 and 2.
2. After discovering that AP students did exceptionally well in M150 we changed the handling of AP scores slightly for 2018 and beyond. An AP AB score of 3 gives credit for M141 (and also Math 120 Business Calculus), so that a student can enroll in M150. An AP BC score of 3 gives credit for M150. (In 2016, we increased AP cutoffs for credit from 3 to 4, based on concern about the pass rates in M150. The new policy gives access to M150, but not credit in it, for a 3 on the AP AB and credit in M150 for a 3 on the AP BC.)
3. Starting in Fall 2018
  - We lowered the ALEKS cutoff for M150 from 78 to 76.
  - We made Math 105 College Algebra a prerequisite for M141. Precalculus will now start at a more advanced level and spend more time on challenging topics.
  - Students may also use ALEKS to place into M141 with a score of 51 on a proctored ALEKS assessment. The cutoff was originally set at 60—the ALEKS recommendation for precalculus—but not enough students were surpassing that score so the cutoff was lowered in mid-July. A lower cutoff, of 41, was used for students in learning communities, since they attend a co-requisite SCI 296 course.
4. During Summer 2018, in addition to constant communication between the department, student advising, and the testing office, emails were sent via the ALEKS system (to all students in the SDSU cohort) and via Blackboard (to all M105 students). These explained that the department is using ALEKS to promote student success and encouraged students to use ALEKS learning modules and retake proctored assessments.

## 2 Background Information on the SDSU Calculus Program and ALEKS PPL

Since 2015, Math 141 Precalculus, Math 150 Calculus 1, and Math 151 Calculus 2 have all been tightly coordinated, using the same textbook and syllabus. All students in each course take the same final and the same midterm exams (on a weekday evening) and are graded according to the same rubric.

Starting in the Fall 2016 semester, the department instituted the following possible entry methods for Calculus I:

- Receive a 3 or better on the AP BC test (or some variant, such as the AB-BC), or a 4 or better on the AP AB test;
- Receive a C or better in Precalculus, Math 141 (or a college equivalent);
- Score 78 or higher on the ALEKS placement test.

As noted in Section 1 these requirements are being loosened starting in Fall 2018. A 3 on the AP AB test and a 76 on ALEKS are now sufficient.

The ALEKS PPL system gives each student an initial assessment of roughly 40 questions and then generates a score between 0 and 100, as well as subscores in 10 general areas (such as Equations and Inequalities, Rational Expressions, Exponentials and Logarithms). A student has unlimited use of learning modules in various topics within each of these general areas, and the opportunity to take up to 4 additional assessments. We set the following policy: a student that received a score of 78 or better on a *proctored* ALEKS assessment could enroll in Calculus 1. Standard practice was that

each student would take the first two assessments on their own (in an online, un-proctored setting) and use the learning modules in ALEKS PPL to address their weak areas. Assessment #3 had to be proctored. If the student did not receive an overall score of 78 or better on assessment #3, the student could take assessment #4 (online, un-proctored), then take a fifth, and final, proctored assessment. The procedure was generally followed except for isolated cases of students taking assessment #1,2, or 4 in a proctored setting. Only the proctored assessments were considered for entry into Math 150.

In Fall 2017 and Spring 2018 we expanded the use of ALEKS PPL in M150. Every student enrolled in M150 was required to take a proctored ALEKS assessment for 5% of their grade. Students that had placed into the course via ALEKS, automatically received the 5 points. Other students, (those placing into M150 via M141 or AP test) were given up to 5 assessments, and they were encouraged to practice on their own and take just 2-3 attempts in a proctored setting. Students scoring over 76 on ALEKS received 5 points, 70-75 received 4, 60-69 received 3, 50-59 received 2 and below 50 received 0. (Note that the cutoff for 5 points is 76 whereas placement into M150 required 78.) This gave a snapshot of incoming student ability, as measured by ALEKS assessment, for the whole class.

### 3 Conclusion and Next Steps

It is clear from our two years experience with ALEKS PPL that it is very useful as a predictor of success in Math 150 Calculus 1. We have also just scratched the surface of its utility. The most obvious next step, now that placement into M141 is required, is to do a similar analysis of ALEKS scores as a predictor of success in Math 141 Precalculus. Most students taking M141, at least in the Fall, will have placed into the course via ALEKS, so we have a good size initial population to study. Another useful aspect of ALEKS PPL is that it provides subscores that indicate student ability in 10 general areas, such as rational expressions or trigonometric functions. It would be useful to analyze the relationship between each subscore and performance in a course to see which is most predictive of success. Finally, it may be beneficial to replace hard cutoffs with something more flexible. One possible approach is to allow students within 3 points of the cutoff for a course to enroll in that course, provided they consult with a tutor at the Mathematics Learning Center and develop a plan to use ALEKS PPL learning modules to improve skills in key areas.

Another conclusion we can draw is that M141 was not adequately preparing students for M150, particularly students that received a C, C+ or B-. By starting the course at a higher level and requiring placement into that course we hope to see better results. The number of students enrolled in M141 in Fall 2018 is only 55% of the number that were enrolled in Fall 2017 (approximately 470 vs 840). Roughly 370 students that would have taken M141 this year are taking Math 105 College Algebra instead. One would hope to see substantial improvements in student performance in M141, both higher rates of real “success” (B- or better) and higher rates of passing the class. We also hope to see much better ALEKS scores for these students when they take ALEKS assessments as part of their grade for M150. There should be higher success rates for these students when they take M150, so that students with a given grade in M141 in Fall 2018, say C+ or B-, have better grades when taking M150 in Spring 2019, than students with that same C+ or B- in Math 141 in Fall 2017 earned when they took M150 in Spring 2018.

We will also track the success of students in M141 that are in the learning communities (who satisfy a lower cutscore but have the extra support of SCI 296) and compare with those that are not in the learning communities.

Finally, there are many questions to ask about the students that are placed into M105, particularly those that are also placed in M105-X, the support course required for some students under the CSU multiple measures guidelines. In addition to studying the ALEKS scores for these students when they eventually do take it, and the grades of these students as they move to M141 and then M150, we have the additional question of comparing the success of those in the support course and those not in it.

## Appendix A Math 150 Calculus 1

In this appendix we present two main topics: (1) a breakdown of the Math 150 Calculus 1 class into various subpopulations and a study of the performance of these subpopulation in Math 150; and (2) analysis of the performance in M150 based on ALEKS scores and also on Math 141, Precalculus grades. We treat the Fall results first and then the Spring because the Fall student population is qualitatively different from the Spring population. In particular, Fall students that are continuing (not Freshman) either started in a remedial course in the Fall of the previous year, or failed a course at some point. Most Spring M150 students took M141 in the previous Fall.

For each semester we break down the student population with regard to 3 parameters. The first is Residence Status (CA resident, non-CA US resident, Foreign, Other). The second we call Entrance Method: it is whether the student placed into Math 150 via AP test (4 or better on the AB test, 3 or better on the BC test), via ALEKS proctored score (78 or better), via Precalculus grade (C or better) or some other means. Roughly 10 students each Fall placed into Calculus via both AP and ALEKS. These students were considered in the AP population not in the ALEKS population. The third parameter, Student Level, is status as 1st year student (matriculated in the Fall of the current academic year) or continuing student.

We give tables listing the number of students with given Residence Status and Entry Method for the whole population, followed by the same breakdown for 1st time students/continuing students. A handful of students are classified as neither 1st time nor continuing, so the sum of the 1st time and continuing tables may be slightly below the value for the whole class. We also give a table with statistical information about student performance in the course, for the whole population and several subpopulations. For each subpopulation we list the number of students in the population, and information about grades: the average grade, and the 1st, 2nd and 3rd quartile grades are listed. The table also shows the proportion of students scoring a non-passing grade in the column marked %DFW, C or above in the column %C, B- or above in the column %B, and A- or above in the column %A. (Note a grade of C- is rarely given and is not considered passing). Charts at the end of this appendix present these results graphically for all four semesters. As an example, in Fall 2016 45 students placed into Math 150 via an AP score. Since the 1st Q is 3.7, at least 75% of those students received an A-, but in fact we see from the %A column that 78% of them received an A- or better. From the %C column 96% passed the class. Students placing in via ALEKS did almost as well, 53% received A- or better and 92% passed. On the other hand, students that placed into Math 150 via Precalculus had a 1st Q score of 1.0 and a 3rd Q of 3.0, only 12% received A- or better and only 59% passed. Note also that 23% of foreign students received an A- or better but only 55% passed, so there is quite a spread of ability among foreign students.

For each semester we present a graph that shows the proportion of Cs (or better), Bs (B- or better), and As (A- or better) awarded in M150 for the students receiving a given M141 grade. The black histogram shows the number of students receiving the M141 grade (read from the right hand vertical axis).

For each semester a second graph shows the proportion of Cs (or better), Bs (B- or better), and As (A- or better) awarded in M150 for a given ALEKS score. For each ALEKS score  $N$ , we take as the population representing that score all students receiving a proctored ALEKS score from  $N - 2$  to  $N + 2$ . This helps smooth out the graph. The black histogram shows the number of students in that population (using the right hand axis). Note that each student appears in 5 consecutive populations.

The M150 exams in Fall 2017 were more challenging than in the previous year, using more challenging conceptual problems. This was because students in M151 Calculus 2 did not seem to be well enough prepared for that class, so the coordinators wanted to push the M150 students to a deeper level of understanding. The Spring 2018 exams may have been still more challenging.

**Fall 2016** This was the first semester that we used ALEKS for placement.

Table 1: Residency and Entrance Method breakdown for the Whole Population

#Students	Resident	Domestic	Foreign	Other Res	Total
AP	43	1	1	0	45
ALEKS	238	11	11	1	261
PreCalc	191	26	14	1	232
Other Ent	34	10	5	2	51
Total	506	48	31	4	589

Table 2: Residency and Entrance Method breakdown by Student Level

# 1st Time Students	Resident	Domestic	Foreign	Other Res	Total
AP	37	0	1	0	38
ALEKS	217	11	7	1	236
PreCalc	0	0	2	0	2
Other Ent	12	7	0	0	19
Total	266	18	10	1	295
#Continuing Students	Resident	Domestic	Foreign	Other Res	Total
AP	6	1	0	0	7
ALEKS	21	0	4	0	25
PreCalc	191	26	12	1	230
Other Ent	22	3	5	0	30
Total	240	30	21	1	292

Table 3: Performance for Various Subpopulations

Population	Number	Average	%DFW	%C	%B	%A	1st Q	2nd Q	3rd Q
WholeClass	589	2.76	22	78	65	38	2.00	3.00	4.00
AP	45	3.59	4	96	89	78	3.70	4.00	4.00
ALEKS	261	3.27	8	92	82	53	3.00	3.70	4.00
PreCalc	232	2.05	41	59	40	12	1.00	2.00	3.00
Other Ent	51	2.66	25	75	63	41	1.85	3.00	4.00
Resident	506	2.86	19	81	67	41	2.00	3.30	4.00
Domestic	48	2.20	40	60	50	17	1.00	2.50	3.30
Foreign	31	2.05	45	55	48	23	0.70	2.30	3.30
Other Res	4	2.33	25	75	50	25	1.72	2.65	3.25
1st Year	295	3.38	7	93	86	59	3.00	3.70	4.00
Continuing	292	2.13	38	62	42	16	1.00	2.30	3.00



**Fall 2017** ALEKS was used for placement, but also for a portion of the grade. The data below and the graph of Math 150 grade and ALEKS score presented next is just for the students that used ALEKS for placement. Figure 1 in Section 1 shows the relationship between ALEKS score and Math 150 grade for the whole class.

Table 4: Residency and Entrance Method breakdown for the Whole Population

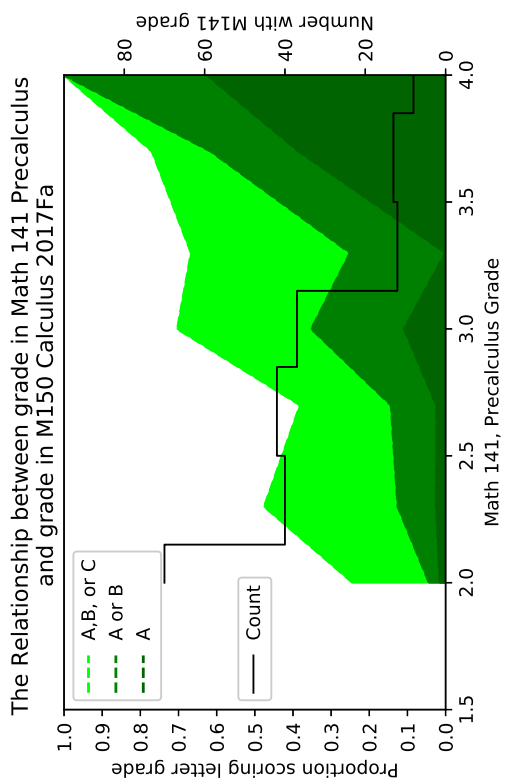
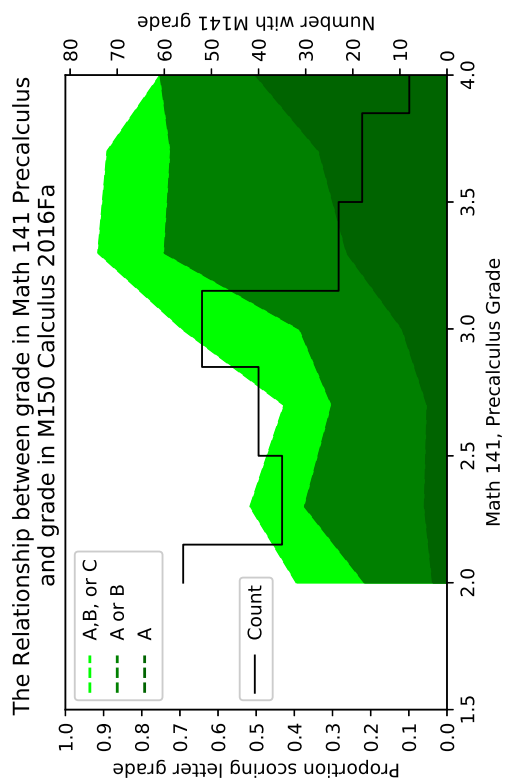
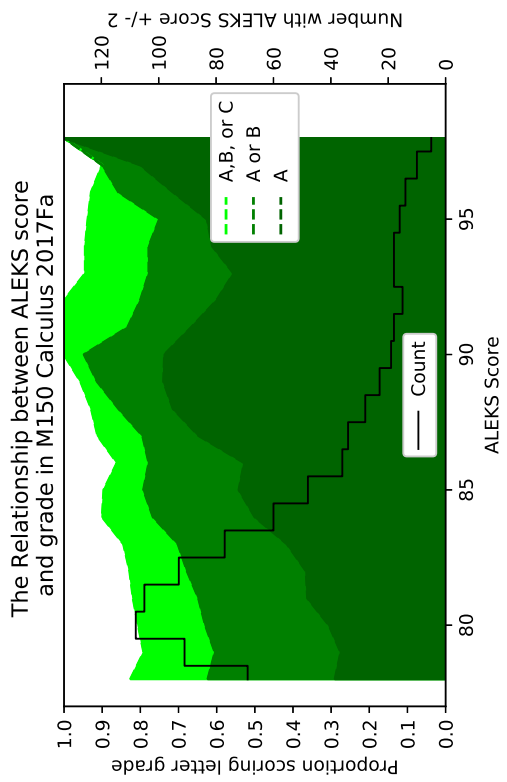
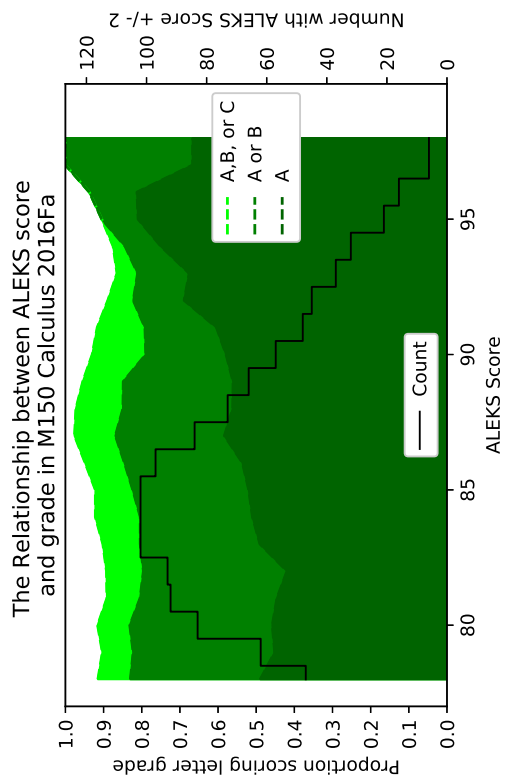
#Students	Resident	Domestic	Foreign	Other Res	Total
AP	41	1	1	0	43
ALEKS	150	17	13	7	187
PreCalc	165	24	19	8	216
Other Ent	29	6	3	1	39
Total	385	48	36	16	485

Table 5: Residency and Entrance Method breakdown by Student Level

#1st Time Students	Resident	Domestic	Foreign	Other Res	Total
AP	32	1	1	0	34
ALEKS	134	16	12	6	168
PreCalc	0	0	3	0	3
Other Ent	19	4	0	0	23
Total	185	21	16	6	228
# Continuing Students	Resident	Domestic	Foreign	Other Res	Total
AP	9	0	0	0	9
ALEKS	16	1	1	1	19
PreCalc	165	24	16	8	213
Other Ent	10	2	3	0	15
Total	200	27	20	9	256

Table 6: Performance of Various Subpopulations

Population	Number	Average	%DFW	%C	%B	%A	1st Q	2nd Q	3rd Q
WholeClass	485	2.32	34	66	47	27	1.30	2.30	3.70
AP	43	3.17	9	91	79	56	3.00	3.70	4.00
ALEKS	187	2.98	14	86	71	43	2.30	3.30	4.00
PreCalc	216	1.61	54	46	21	8	0.70	1.70	2.30
Other Ent	39	2.12	41	59	44	21	1.00	2.30	3.15
Resident	385	2.36	32	68	48	28	1.30	2.30	3.70
Domestic	48	1.96	46	54	35	12	0.93	2.00	3.00
Foreign	36	2.47	33	67	53	33	1.60	2.70	3.78
Other Res	16	2.08	44	56	44	31	0.75	2.00	3.78
1st Year	228	3.02	14	86	73	46	2.30	3.30	4.00
Continuing	256	1.70	51	49	24	10	1.00	1.70	2.30



**Spring 2017** ALEKS was used for placement, but relatively few students used ALEKS over the Winter to place into M150.

Table 7: Residency and Entrance Method breakdown for the Whole Population

#Students	Resident	Domestic	Foreign	Other Res	Total
AP	10	0	0	1	11
ALEKS	48	8	8	1	65
PreCalc	375	38	43	11	467
Other Ent	21	3	11	3	38
Total	454	49	62	16	581

Table 8: Residency and Entrance Method breakdown

#1st Time Students	Resident	Domestic	Foreign	Other Res	Total
AP	7	0	0	0	7
ALEKS	42	7	3	1	53
PreCalc	284	32	30	7	353
Other Ent	10	2	2	0	14
Total	343	41	35	8	427

#Continuing	Resident	Domestic	Foreign	Other Res	Total
AP	3	0	0	1	4
ALEKS	6	1	5	0	12
PreCalc	91	6	13	4	114
Other Ent	11	1	9	2	23
Total	111	8	27	7	153

Table 9: Performance of Various Subpopulations

Population	Number	Average	%DFW	%C	%B	%A	1st Q	2nd Q	3rd Q
WholeClass	581	2.01	42	58	37	18	1.00	2.00	3.00
AP	11	3.30	18	82	73	64	2.80	4.00	4.00
ALEKS	65	2.09	35	65	42	22	0.70	2.30	3.00
PreCalc	467	1.95	43	57	35	15	1.00	2.00	3.00
Other Ent	38	2.21	47	53	45	29	1.00	2.00	3.70
Resident	454	2.06	40	60	39	19	1.00	2.00	3.00
Domestic	49	1.57	57	43	22	8	0.70	1.70	2.30
Foreign	62	2.00	44	56	34	21	1.00	2.00	3.00
Other Res	16	1.98	44	56	44	12	0.98	2.30	3.08
1st Year	427	2.08	40	60	40	18	1.00	2.00	3.00
Continuing	153	1.82	48	52	29	17	0.70	2.00	2.70

**Spring 2018** ALEKS was used for placement, but also for a portion of the grade. The data below and the graph of Math 150 grade and ALEKS score presented next is just for the students that used ALEKS for placement. Figure 1 in Section 1 shows the relationship between ALEKS score and Math 150 grade for the whole class.

Table 10: Residency and Entrance Method breakdown for the Whole Population

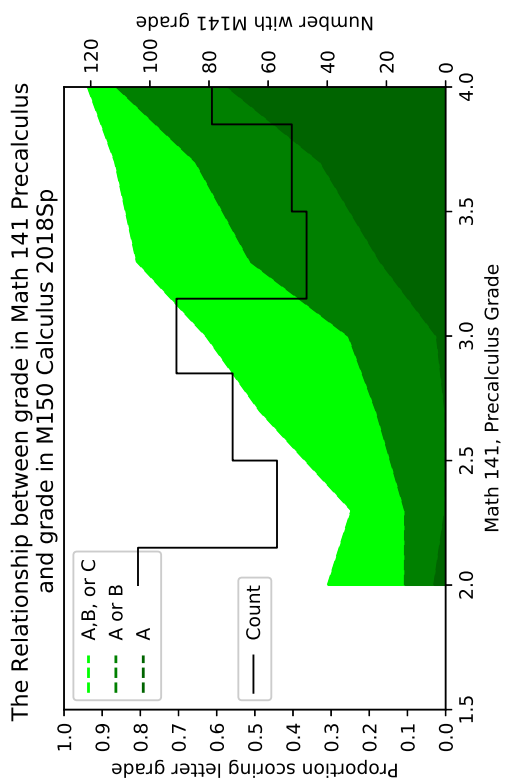
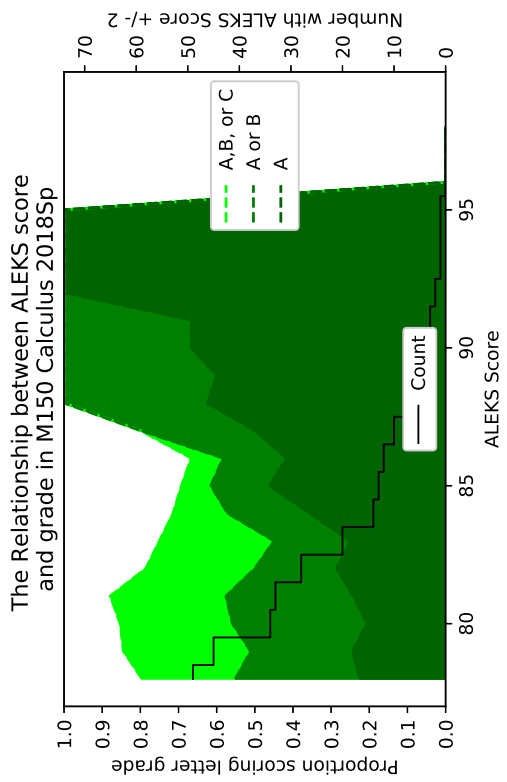
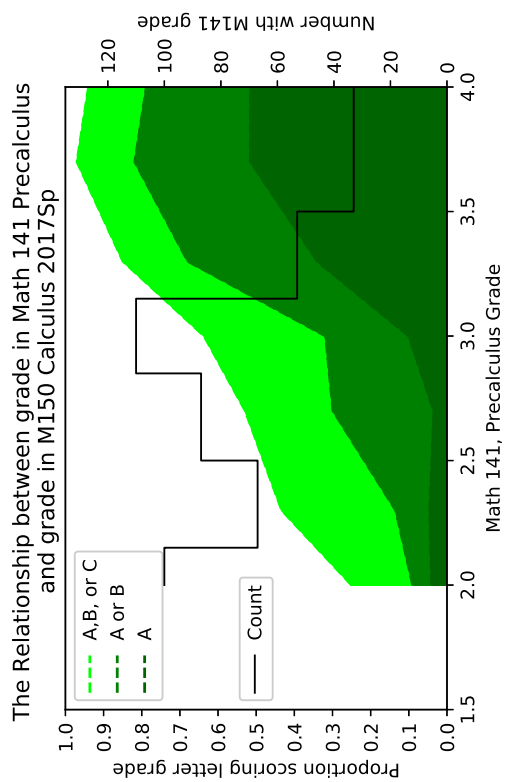
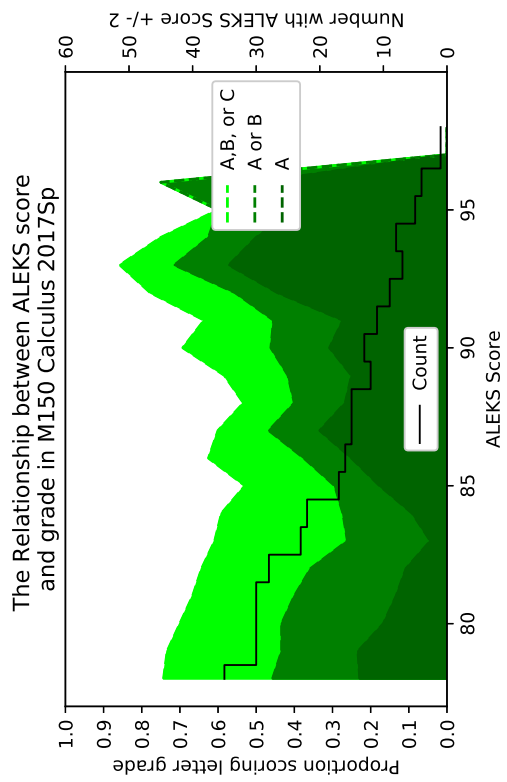
#Students	Resident	Domestic	Foreign	Other Res	Total
AP	14	1	0	0	15
ALEKS	38	6	6	1	51
PreCalc	403	32	32	20	487
Other Ent	24	0	4	0	28
Total	479	39	42	21	581

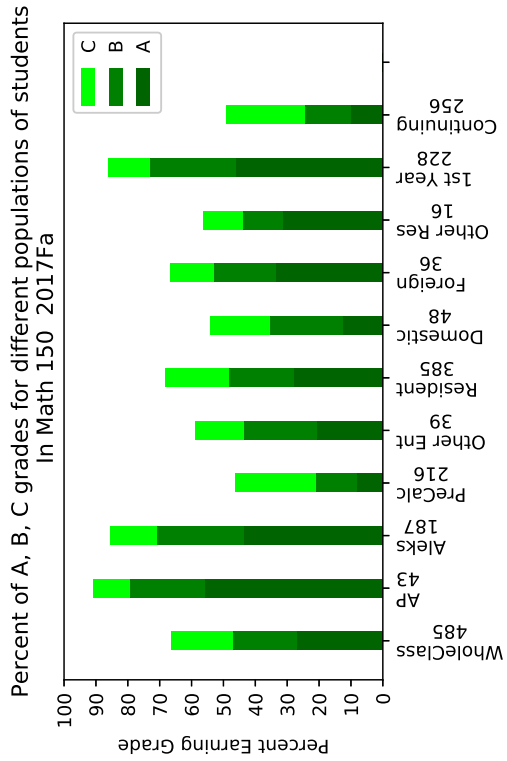
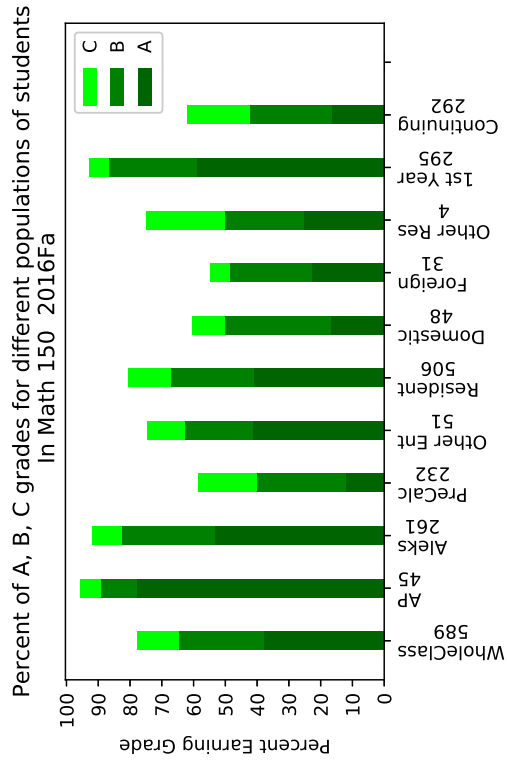
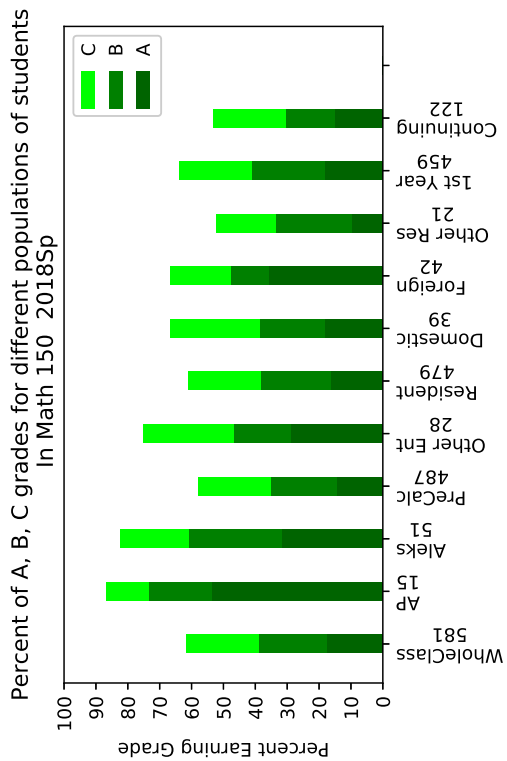
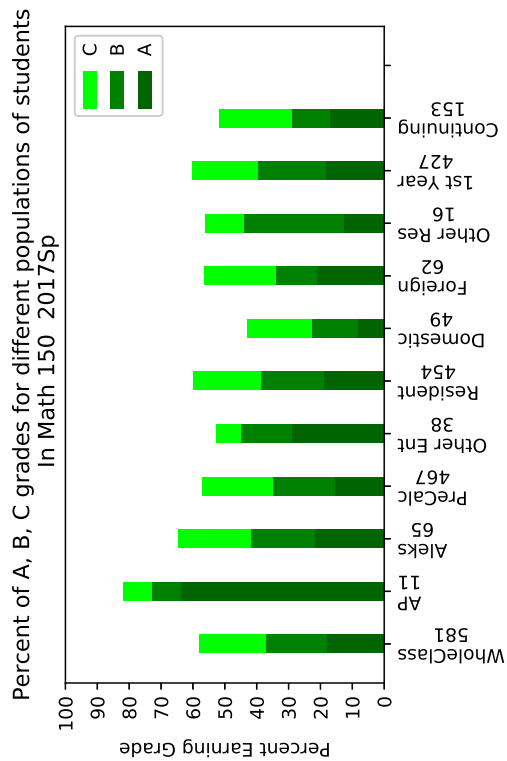
Table 11: Residency and Entrance Method breakdown

#1st Time Students	Resident	Domestic	Foreign	Other Res	Total
AP	7	1	0	0	8
ALEKS	32	5	6	1	44
PreCalc	324	27	28	12	391
Other Ent	16	0	0	0	16
Total	379	33	34	13	459
# Continuing Students	Resident	Domestic	Foreign	Other Res	Total
AP	7	0	0	0	7
ALEKS	6	1	0	0	7
PreCalc	79	5	4	8	96
Other Ent	8	0	4	0	12
Total	100	6	8	8	122

Table 12: Performance of Various Subpopulations

Population	Number	Average	%DFW	%C	%B	%A	1st Q	2nd Q	3rd Q
WholeClass	581	2.10	38	62	39	17	1.00	2.00	3.00
AP	15	2.98	13	87	73	53	2.50	3.70	4.00
ALEKS	51	2.71	18	82	61	31	2.00	3.00	3.85
PreCalc	487	1.99	42	58	35	14	1.00	2.00	3.00
Other Ent	28	2.40	25	75	46	29	1.93	2.30	4.00
Resident	479	2.07	39	61	38	16	1.00	2.00	3.00
Domestic	39	2.13	33	67	38	18	1.00	2.00	3.00
Foreign	42	2.48	33	67	48	36	1.40	2.30	4.00
Other Res	21	1.88	48	52	33	10	1.00	2.00	2.70
1st Year	459	2.16	36	64	41	18	1.00	2.00	3.00
Continuing	122	1.86	47	53	30	15	1.00	2.00	2.70



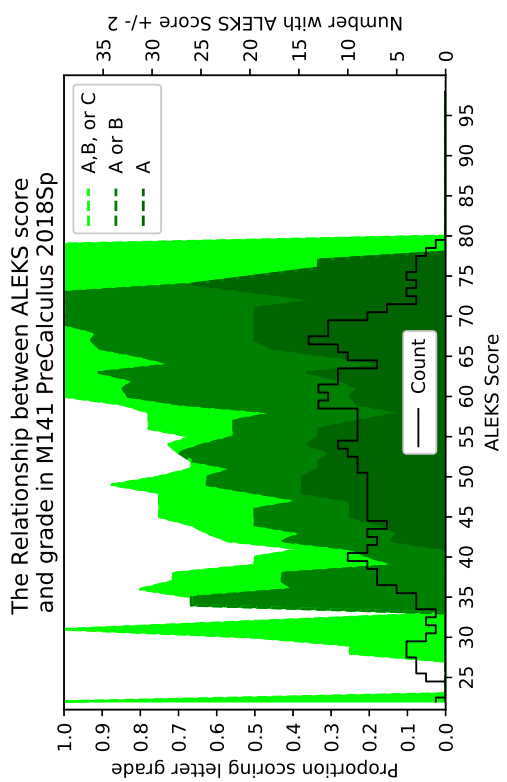
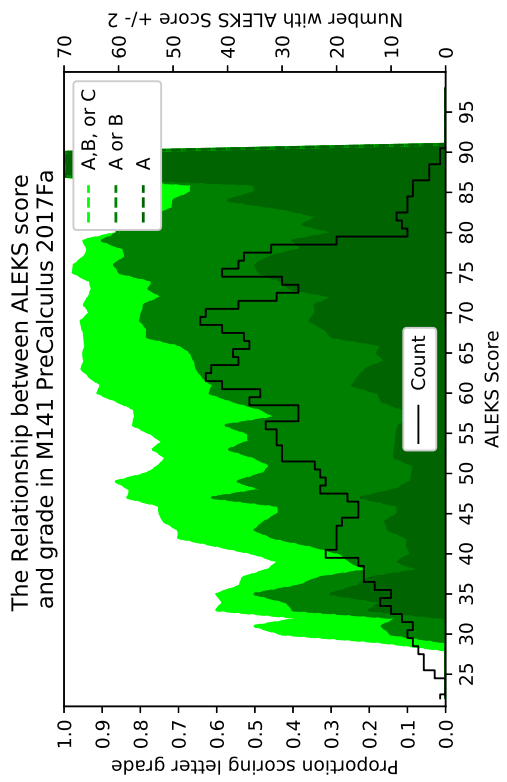
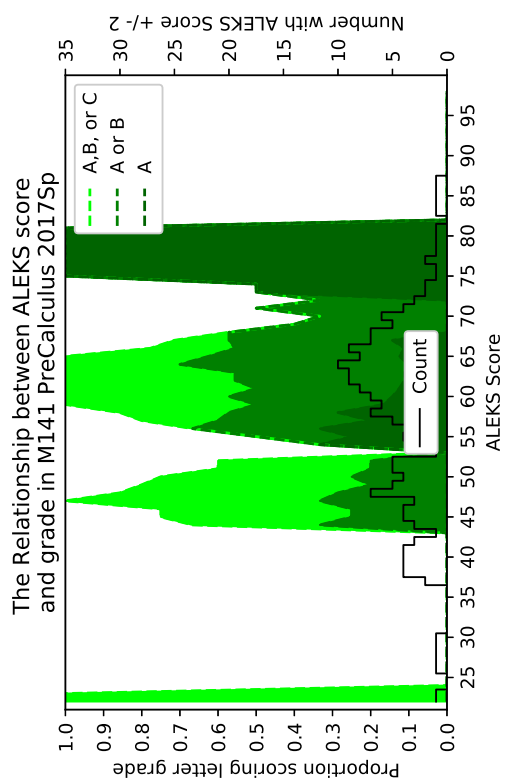
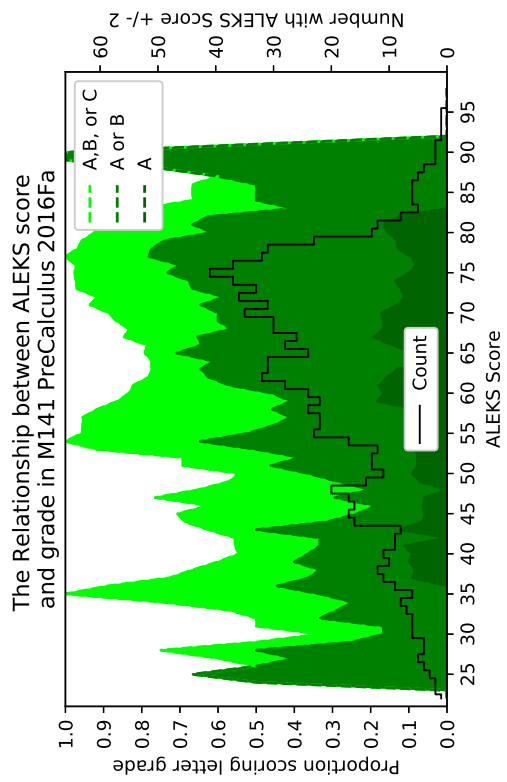


## Appendix B Math 141: Precalculus

In this appendix we parallel the analysis for M150 as much as possible with two main topics: (1) a breakdown of the M141 class into various subpopulations and a study of the performance of each subpopulation in M141; and (2) analysis of the performance in M141 based on ALEKS scores for those that have an ALEKS score. These students took the ALEKS assessment to attempt to enroll in M150, so they are a select population. Also the ALEKS score may not be reliable, because some students may have given up the effort after realizing they would not receive a high enough score to get into M150. Nevertheless, it is worth considering. The following page has charts for the proportion of A's B's and C's obtained in M141 for a given ALEKS score. As with M150, for each ALEKS score  $N$ , we take as the population representing that score all students receiving a proctored ALEKS score from  $N - 2$  to  $N + 2$ . This helps smooth out the graph. The black line shows the number of students in that population.

For each semester we break down the student population with regard to two of the same three parameters as for M150: Residence Status (CA resident, non-CA US resident, Foreign, Other); and Student Level (First Year or not). For M141, which had no prerequisites (other than ELM proficiency), there isn't an analogous Entry Method, but many students used ALEKS to try to get into M150. In place of Entrance Method we separate the population into those that did not use ALEKS, those that did and scored over 60—the ALEKS recommended cut-score for Precalculus of 60—and those used ALEKS and scored below 60.

We give tables listing the number of students with given Residence Status and “Entrance Method” for the whole population, followed by the same breakdown for 1st time students/continuing students in Fall. We also give a table with statistical information about student performance in the course, for the whole population and several subpopulations. The number of students in the population, the average score, and the quartile scores are listed. We also give the proportion of students scoring C or above in the column %C, B- or above in the column %B, and A- or above in the column %A. Charts at the end of this appendix present these results graphically for all four semesters.





**2016 Fall** Some students took ALEKS to attempt to get into M150, but ALEKS was not used for placement into M141.

Table 13: Residency and Entrance Method breakdown for the Whole Population

#Students	Resident	Domestic	Foreign	Other Res	Total
AP	1	0	0	0	1
ALEKS over Cutoff	115	12	12	1	140
ALEKS below Cutoff	65	5	7	1	78
Other Ent	401	50	59	12	522
Total	582	67	78	14	741

Table 14: Residency and Entrance Method breakdown by Student Level

#1st Time Students	Resident	Domestic	Foreign	Other Res	Total
AP	1	0	0	0	1
ALEKS over Cutoff	111	11	10	1	133
ALEKS below Cutoff	63	5	4	1	73
Other Ent	298	38	34	9	379
Total	473	54	48	11	586
#Continuing Students	Resident	Domestic	Foreign	Other Res	Total
AP	0	0	0	0	0
ALEKS over Cutoff	4	1	2	0	7
ALEKS below Cutoff	2	0	3	0	5
Other Ent	103	12	25	3	143
Total	109	13	30	3	155

Table 15: Performance of Various Subpopulations

Population	Number	Average	%DFW	%C	%B	%A	1st Q	2nd Q	3rd Q
WholeClass	747	2.21	25	75	48	9	1.70	2.30	3.00
AP	1	0.70	100	0	0	0	0.70	0.70	0.70
ALEKS over Cutoff	140	2.62	13	87	65	13	2.30	2.70	3.30
ALEKS below Cutoff	78	2.09	24	76	36	5	2.00	2.30	2.70
Other Ent	522	2.13	29	71	46	9	1.30	2.30	3.00
Resident	586	2.33	22	78	51	10	2.00	2.70	3.00
Domestic	67	1.96	33	67	36	3	1.30	2.00	2.70
Foreign	80	1.61	46	54	36	8	0.00	2.00	2.78
Other Res	14	1.95	36	64	50	0	0.85	2.50	3.00
1st Year	591	2.36	21	79	53	10	2.00	2.70	3.00
Continuing	156	1.64	43	57	30	5	0.00	2.00	2.70

**2017 Fall** Some students took ALEKS, to attempt to get into M150, but ALEKS was not used for placement into M141.

Table 16: Residency and Entrance Method breakdown for the Whole Population

#Students	Resident	Domestic	Foreign	Other Res	Total
AP	2	0	0	0	2
ALEKS over Cutoff	131	18	9	2	160
ALEKS below Cutoff	99	10	6	3	118
Other Ent	424	50	46	22	542
Total	656	78	61	27	822

Table 17: Residency and Entrance Method breakdown by Student Level

#1st Time Students	Resident	Domestic	Foreign	Other Res	Total
AP	1	0	0	0	1
ALEKS over Cutoff	129	18	9	1	157
ALEKS below Cutoff	94	9	3	3	109
Other Ent	326	38	37	17	418
Total	550	65	49	21	685
#Continuing Students	Resident	Domestic	Foreign	Other Res	Total
AP	1	0	0	0	1
ALEKS over Cutoff	2	0	0	1	3
ALEKS below Cutoff	5	1	3	0	9
Other Ent	97	12	9	3	121
Total	105	13	12	4	134

There were 19 students that were neither 1st time nor continuing.

Table 18: Performance of Various Subpopulations

Population	Number	Average	%DFW	%C	%B	%A	1st Q	2nd Q	3rd Q
WholeClass	827	2.28	28	72	51	19	1.30	2.70	3.30
AP	2	2.85	0	100	100	0	2.78	2.85	2.92
ALEKS over Cutoff	160	3.00	6	94	75	33	2.60	3.00	3.70
ALEKS below Cutoff	118	2.19	29	71	45	12	1.30	2.30	3.00
Other Ent	542	2.09	33	67	45	16	1.00	2.30	3.00
Resident	660	2.39	24	76	55	20	2.00	2.70	3.30
Domestic	78	1.98	37	63	37	12	1.00	2.00	3.00
Foreign	62	1.81	45	55	40	19	0.00	2.00	3.00
Other Res	27	1.41	52	48	19	7	0.00	1.70	2.00
1st Year	687	2.40	24	76	55	21	2.00	2.70	3.30
Continuing	137	1.67	44	56	33	8	0.00	2.00	2.70

**2017 Spring** A small number of students used ALEKS to attempt to get into M150, were not successful and enrolled in M150 in the Spring.

Table 19: Residency and Entrance Method breakdown for the Whole Population

#Students	Resident	Domestic	Foreign	Other Res	Total
AP	0	0	0	0	0
ALEKS over Cutoff	26	2	2	1	31
ALEKS below Cutoff	37	2	1	2	42
Other Ent	321	57	31	14	423
Total	384	61	34	17	496

Table 20: Residency and Entrance Method breakdown by Student Level

#1st Time Students	Resident	Domestic	Foreign	Other Res	Total
AP	0	0	0	0	0
ALEKS over Cutoff	23	2	1	1	27
ALEKS below Cutoff	33	2	1	2	38
Other Ent	247	53	25	12	337
Total	303	57	27	15	402

#Continuing	Resident	Domestic	Foreign	Other Res	Total
AP	0	0	0	0	0
ALEKS over Cutoff	3	0	1	0	4
ALEKS below Cutoff	4	0	0	0	4
Other Ent	73	4	6	1	84
Total	80	4	7	1	92

Table 21: Performance of Various Subpopulations

Population	Number	Average	%DFW	%C	%B	%A	1st Q	2nd Q	3rd Q
WholeClass	452	1.94	38	62	37	13	1.00	2.00	3.00
AP	1	1.30	100	0	0	0	1.30	1.30	1.30
ALEKS over Cutoff	22	2.45	23	77	55	18	2.00	2.85	3.22
ALEKS below Cutoff	18	1.74	44	56	28	6	1.00	2.00	2.60
Other Ent	409	1.93	39	61	37	13	1.00	2.00	3.00
Resident	330	2.02	36	64	38	15	1.00	2.00	3.00
Domestic	57	1.90	40	60	42	4	1.00	2.30	3.00
Foreign	49	1.46	55	45	29	12	0.00	1.30	2.70
Other Res	16	2.02	25	75	25	6	1.75	2.00	2.40
1st Year	353	2.00	36	64	39	13	1.00	2.00	3.00
Continuing	97	1.75	46	54	31	13	0.00	2.00	3.00

Spring 2018 This is the breakdown for Whole Population

Table 22: Residency and Entrance Method breakdown for the Whole Population

#Students	Resident	Domestic	Foreign	Other Res	Total
AP	1	0	0	0	1
ALEKS over Cutoff	15	5	2	0	22
ALEKS below Cutoff	12	2	3	1	18
Other Ent	301	50	43	15	409
Total	329	57	48	16	450

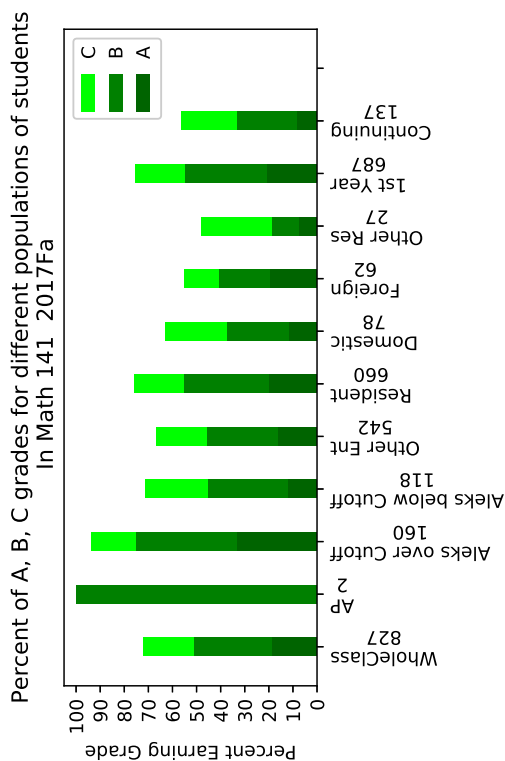
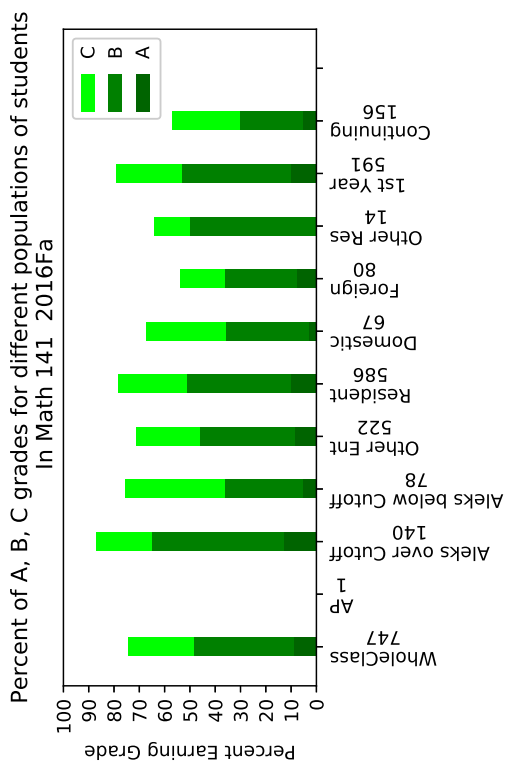
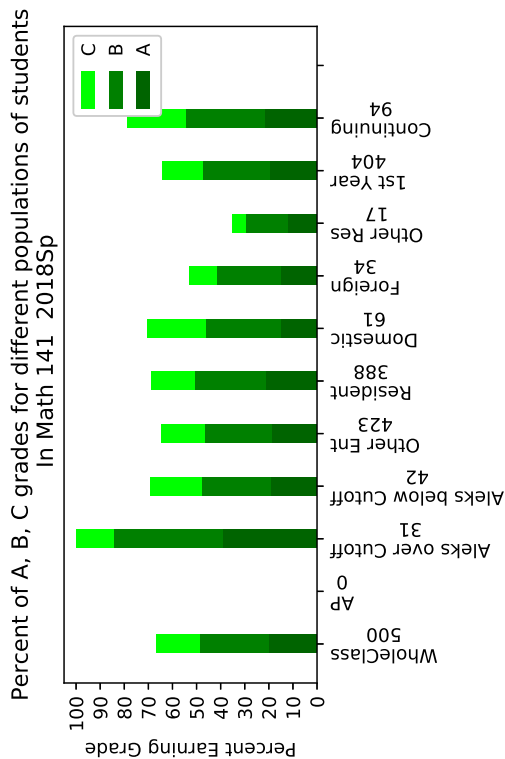
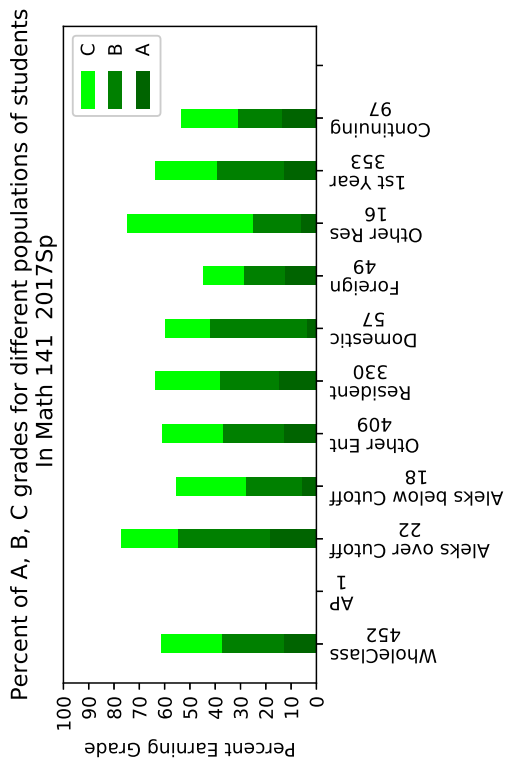
Table 23: Residency and Entrance Method breakdown by Student Level

#1st Time	Resident	Domestic	Foreign	Other Res	Total
AP	1	0	0	0	1
ALEKS over Cutoff	14	4	1	0	19
ALEKS below Cutoff	12	2	3	1	18
Other Ent	242	45	21	6	314
Total	269	51	25	7	352
#Continuing	Resident	Domestic	Foreign	Other Res	Total
AP	0	0	0	0	0
ALEKS over Cutoff	1	1	1	0	3
ALEKS below Cutoff	0	0	0	0	0
Other Ent	59	5	22	7	93
Total	60	6	23	7	96

Here are statistics for various subpopulations of the students.

Table 24: Performance of Various Subpopulations

Population	Number	Average	%DFW	%C	%B	%A	1st Q	2nd Q	3rd Q
WholeClass	500	2.14	33	67	48	20	1.00	2.30	3.30
AP	0	0.00	0	0	0	0	0.00	0.00	0.00
ALEKS over Cutoff	31	3.15	0	100	84	39	2.70	3.00	3.70
ALEKS below Cutoff	42	2.08	31	69	48	19	1.00	2.30	3.00
Other Ent	423	2.08	35	65	46	18	0.70	2.30	3.30
Resident	388	2.22	31	69	50	21	1.30	2.70	3.30
Domestic	61	2.11	30	70	46	15	1.30	2.30	3.00
Foreign	34	1.62	47	53	41	15	0.00	2.00	3.00
Other Res	17	1.35	65	35	29	12	0.00	0.70	2.70
1st Year	404	2.08	36	64	47	19	0.70	2.30	3.08
Continuing	94	2.44	21	79	54	21	2.00	2.70	3.30



## Appendix C Statistics for ALEKS Assessments

We treat four different data sets in this appendix. Two are for placement in Math 150 Calculus 1: one in Summer 2016 and the other in Summer 2017. The other two were done in the first weeks of the semester: one in Fall 2017, the other in Spring 2018. In those two semesters, 5% of a student's grade in Math 150 was determined by their ALEKS score. Students that had placed into the course via ALEKS received all 5 points automatically. Students that placed into Math 150 via credit for Math 141 Precalculus or via AP score had to take ALEKS in a proctored setting as described at the end of Section 2. In the data sets for Fall 2017 and Spring 2018 we consider just the students that were using ALEKS for a portion of their grade, that is, those that placed into M150 via M141 and AP. ALEKS was used for placement prior to Spring classes, but we don't report on those cohorts because the number of students in them is small.

The following tables show various statistics for each data set. This first table shows the number of students in each data set, and the number that passed in the  $n$ th attempt at a *proctored assessment* for  $n = 1, 2, 3, 4$ . The remainder failed, although some may not have attempted a proctored assessment. It is interesting that more students used ALEKS in Summer 2017 than in Summer 2016, but far fewer passed on the 1st attempt. We don't have an explanation for this. It is also interesting to see that only 71 of the 248 students that used ALEKS in Fall 2017 (most of whom took Precalculus to get into the the Math 150 Calculus 1 class) achieved a score of 76 or better. (The number that passed in the Fall 2017 and Spring 2018 columns are relative to a 76 cutoff for full credit.) The number of students that took ALEKS for Spring 2018 is much higher, since most came from the Fall 2017 Precalculus class. A slightly higher proportion of them achieved an ALEKS score of 76 or better ( $136/419 = .32$  compared to  $71/248 = .29$ )

Data Set	Number Students	Number Failed	Number Passed			
			1st try	2nd try	3rd try	4th try
Summer 2016	602	302	249	51	0	0
Summer 2017	730	512	159	57	2	0
Fall 2017	248	177	40	26	5	0
Spring 2018	419	283	118	15	2	1

The next table shows the average and standard deviation of the number of assessments taken, as well as the number of proctored assessments taken. Histograms of the number of assessments (and proctored assessments) are given on the following pages. For students using ALEKS for placement into M150, most take three assessments, a few stop at the first (perhaps discouraged), those who take two almost always take a third, and those that take a fourth almost always take a fifth (the third and fifth being proctored). We do see more evidence of discouragement in Summer 2017 (stopping at the first or second assessment).

Data Set	Number of Students	Number Proctored		Number Assessments	
		Average	St. Dev.	Average	St. Dev.
Summer 2016	602	1	0.58	3.0	1.15
Summer 2017	730	0.98	0.66	2.8	1.25
Fall 2017	248	1.25	0.73	2.4	1.16
Spring 2018	419	1.05	0.621	2.34	1.13

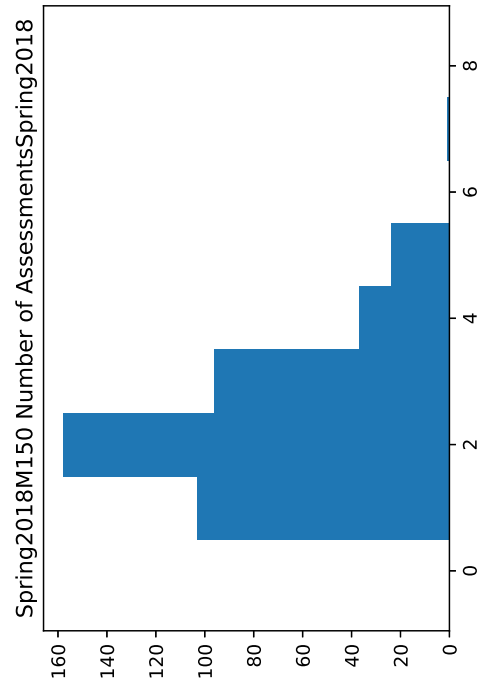
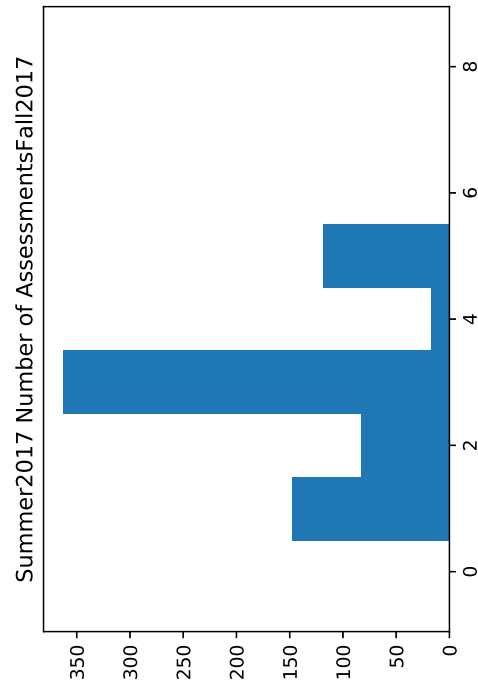
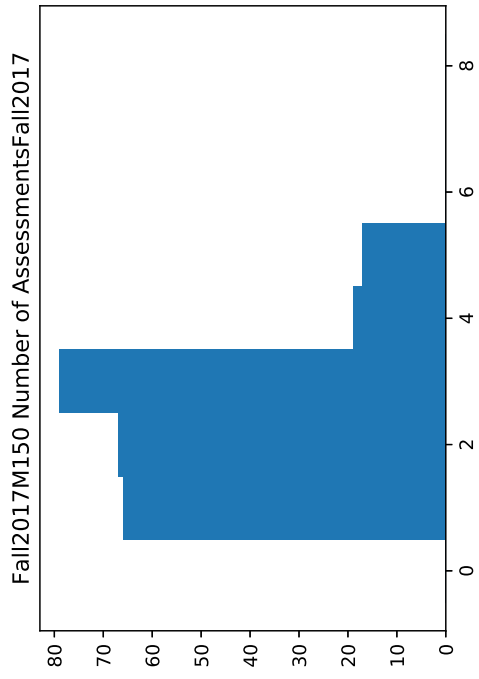
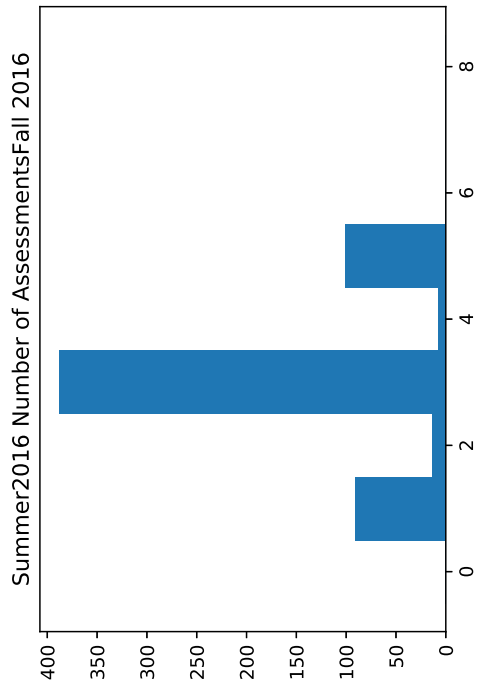
The following table shows data for students that completed a proctored ALEKS score. The first set of data is for the maximum proctored score that a student received, the second set is for students that took more than one proctored assessment and concerns the difference between the students highest and lowest proctored score. The data listed are the number of students, the average, standard deviation, and the 1st, 2nd and 3rd quartiles. The final table below gives the same data for the difference between the maximum unproctored score and the maximum proctored score, for those students that took both a proctored and unproctored assessment. Histograms for all of these are shown on the following pages.

Data Set	Max Proctored ALEKS Score				Max – Min Proctored Range			
Summer 2016	498	76.1	13.9	[69.0, 80.0, 86.0]	102	8.9	5.0	[5.0, 8.0, 12.0]
Summer 2017	569	68.5	16.0	[58.0, 73.0, 81.0]	140	10.9	8.2	[5.0, 9.0, 15.25]
Fall 2017	219	65.9	14.6	[56.0, 68.0, 78.0]	80	12.85	9.2	[6.0, 11.0, 17.25]
Spring 2018	363	68.2	14.2	[59.5, 72.0, 78.0]	64	14.3	10.9	[6.0, 11.0, 20.25]

Data Set	Max Unproctored – MaxProctored			
Summer 2016	498	-3.5	9.7	[-6.0, -3.0, 0.0]
Summer 2017	542	3.8	13.5	[-3.0, 3.0, 10.0]
Fall 2017	161	-6.7	25.5	[-13.0, -3.0, 8.0]
Spring 2018	292	-4.0	20.3	[-10.0, 0.0, 7.25]

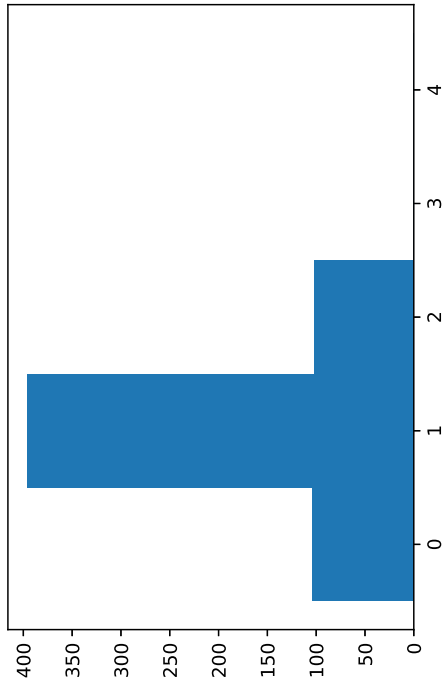
There are several things to note here.

- (Perhaps most interesting) Students that took more than one proctored ALEKS assessment improved by roughly 10 points on average in each cohort, even more in Spring 2018, and there is wide variation.
- Surprisingly, the difference—maximum unproctored score – maximum proctored score—is usually slightly negative on average, with high standard deviation (10 -20 points depending on the cohort). A likely explanation is that students tend to increase their score each time they take an assessment, and the last assessment taken is almost always proctored. There may also be a lot of variation in the effort put in, and the use of resources on unproctored assessments to help solve problems.
- Histograms for the ALEKS scores are given below. One disconcerting observation is that a large number of students in the Fall 2017 and Spring 2018 cohorts—who are enrolled in M150—score well below 60 on ALEKS, which is the usual cutoff for precalculus.
- Many students using ALEKS for placement (the Summer contingents) don't even take a proctored assessment—16% in 2016 and 20% in 2017—hence the lower count in the final table than in previous tables. For those taking ALEKS for a portion of their grade the percentage not taking a proctored assessment is 12-14%.
- The lower averages and quartiles for Summer 2017 correspond to the lower number of students surpassing the cutoff, as we observed above. Again, we have no explanation for that.
- The students taking ALEKS for a portion of their grade (as opposed to placement) have lower scores than the Summer 2016 students, but are roughly on par with the Summer 2017 students.

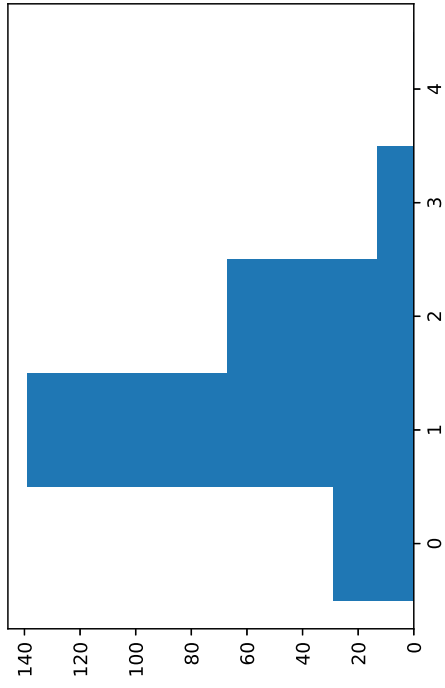




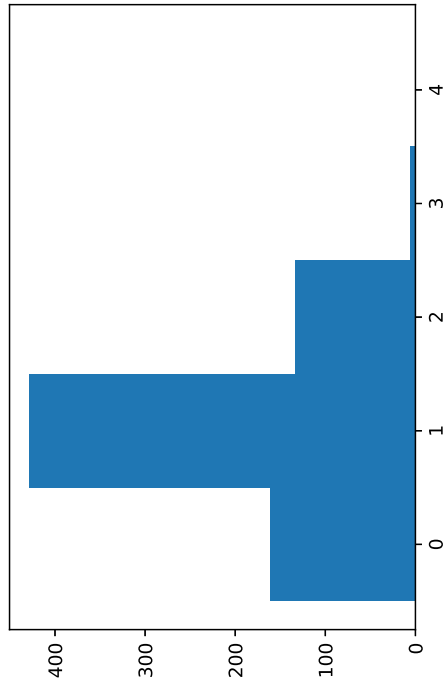
Summer2016 Number of Proctored AssessmentsFall 2016



Fall2017M150 Number of Proctored AssessmentsFall2017



Summer2017 Number of Proctored AssessmentsFall2017



Spring2018M150 Number of Proctored AssessmentsSpring2018

